**Before the**
**FEDERAL COMMUNICATIONS COMMISSION**
**Washington, D.C. 20554**

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| In the Matter of | ) | |
| | ) | |
| Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band | ) | WT Docket No. 07-293 |
| | ) | |
| Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band | ) | IB Docket No. 95-91<br>Gen. Docket No. 90-357<br>RM No. 8610 |
| | ) | |

**COMMENTS OF SIRIUS SATELLITE RADIO INC.**


Patrick L. Donnelly
Executive Vice President, General Counsel,
and Secretary
Sirius Satellite Radio Inc.
1221 Avenue of the Americas
36th Floor
New York, NY 10020

Richard E. Wiley
Robert L. Pettit
Carl R. Frank
Wiley Rein LLP
1776 K Street, NW
Washington, DC 20006
(202) 719-7000

*Attorneys for Sirius Satellite Radio Inc.*


February 14, 2008

# SUMMARY

Sirius Satellite Radio Inc. ("Sirius") hereby submits these comments and technical analysis in response to the Notice of Proposed Rule Making designed to finalize regulations for the authorization of satellite radio terrestrial repeaters and simultaneously to consider changes to the rules governing operations to the 2.3 GHz Wireless Communications Services ("WCS").

Satellite radio service is a Commission success story. Serving more than 16 million subscribers, Sirius and XM Radio have invested billions in spectrum and hardware to ensure that satellite-based transmissions of news and entertainment programming are available at a service availability level of more than 99 percent within the continental United States ("CONUS"). The FCC must ensure that continued success and service to millions of American consumers is not hampered by inefficient and unnecessary regulatory processes that impede the deployment of terrestrial satellite repeaters or by harmful interference from adjacent band operations.

As the Commission has repeatedly recognized, terrestrial repeaters are needed to improve reception in areas where the satellite signals experience increased path loss, such as urban canyons or suburban areas with dense foliage. Consistent with the flexibility provided to other licensees with exclusive use of wide-area spectrum, Sirius urges the Commission to grant "blanket authority" for satellite radio licensees to deploy terrestrial repeaters that conform to the FCC's technical standards.

With regard to compatibility with adjacent band WCS operations, the FCC's policies require WCS operators to protect adjacent channel satellite radio services and the millions of consumers that they now serve. The need to protect satellite radio led to the adoption of stringent technical standards for WCS operations that, in the FCC's opinion, "may make mobile operations in the WCS spectrum technologically infeasible." Choosing to ignore this history, the WCS operators are pursuing a series of technical rule changes to better facilitate the introduction of commercial mobile service while downplaying and ignoring any impact to satellite radio. If adopted, such proposals would generate crippling interference to consumers' satellite radio receivers.

In contrast to the proposals submitted by WCS licensees, Sirius continues to support its previously submitted recommendation to manage adjacent band interference through ground-level emission limits for terrestrial repeaters and WCS base stations. A ground-level emission limit will allow both WCS and satellite radio operators the flexibility to consider a number of operating parameters, including power, antenna height, down tilt and antenna pattern, balancing coverage build-out mindful of the relevant status and sensitivity of adjacent spectrum networks. However, Sirius has determined that certain modifications to its original proposal are necessary. Taking into consideration the spectrum use of the operators in both bands, Sirius proposes a more restrictive ground-level emission limit for operations in the WCS C and D blocks that are directly adjacent to satellite radio operations. In addition, Sirius has determined that operations in the WCS band require less protection than originally proposed and that satellite radio terrestrial repeaters can therefore operate at a less restrictive ground-level emission limit without significantly interfering with WCS operations.

WCS mobile stations operating at any appreciable power pose an extremely high risk of interference to satellite mobile receivers when in close proximity and, consequently, Sirius proposes technical limitations on mobile operations in the WCS band. The limits that Sirius recommends are consistent with the recommendations of many commercial wireless interests submitted in the FCC's proceedings concerning Advanced Wireless Services in the 2.1 GHz bands.

Finally, in order further to protect millions of existing satellite radio consumers, Sirius also recommends that the Commission grandfather its existing network of repeaters. Approximately 40 percent of these sites operate at 2,000 Watts or less effective isotropic radiated power (EIRP), a level recognized by WCS licensees as non-problematic. The sites that operate with more than 2,000 Watts have been in operation for years and they are essential to providing quality service to subscribers. Such facilities are unlikely to pose any interference risk to WCS operations while the alternative of replacing higher-power transmitters with scores of repeaters operating at lower powers would increase potential interference to WCS operations.

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**COMMENTS OF SIRIUS SATELLITE RADIO INC.**

Sirius Satellite Radio Inc. ("Sirius") hereby submits these comments and technical analysis in response to the Notice of Proposed Rule Making in the above-captioned proceeding.[1] Sirius commends the FCC for its commitment to resolving the long-standing issues associated with allowing the routine deployment of terrestrial satellite repeaters in the spectrum allocated to the Satellite Digital Audio Radio Service ("satellite radio").[2]

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1 *Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band, Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band, WT Docket No. 07-293, IB Docket No. 95-91*, Notice of Proposed Rulemaking and Further Notice of Proposed Rulemaking, FCC 07-215 (Dec. 18. 2007) ("Notice").

2 These issues have been before the FCC in one guise or another for more than a decade, starting with the 1995 NPRM that sought to establish rules for satellite radio operations. *See Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band,* Notice of Proposed Rulemaking, 11 FCC Rcd 1, 15 (¶ 55) (1995) ("Satellite Radio NPRM"). Two years later, a further NPRM followed. *See Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band,* Report and Order, Memorandum Opinion and Order and Further Notice of Proposed Rulemaking, 12 FCC Rcd 5754 (1997). Even thereafter, the Commission sought additional comment on remaining terrestrial repeater issues, *see* Public Notice, "*Request for Further Comment on*

This document consists of a narrative portion as well as three technical exhibits, all of which are essential to a complete understanding of Sirius' recommendations. For the Commission's convenience, Sirius and XM Satellite Radio Inc. ("XM") have provided technical exhibits that are similar in form but differ in that each has provided company-specific technical information. Exhibit A provides a description of the satellite radio spectrum and system deployment, analyzes the interference environment between satellite radio and the Wireless Communications Service ("WCS"), and provides additional support for the rule changes that Sirius proposes herein. Exhibit B analyzes the impact of a Commission refusal to grandfather existing terrestrial repeaters. Exhibit C presents an explanation of experiments and field tests undertaken by Sirius to support the conclusions discussed in Exhibit A and throughout these comments. References to specific sections of these exhibits are contained throughout this document.

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*Selected Issues Regarding the Authorization of Satellite Digital Audio Radio Service Terrestrial Repeater Networks*," Report No. SPB-176, 16 FCC Rcd 19435 (Int'l Bur. 2001), and the parties themselves attempted to come to a private resolution of these issues, to no avail. As an "interim" measure, Sirius built and has operated its repeater network over the past six years through a process of expensive, time-consuming requests for special temporary authority limited to a non-interference, secondary basis. *See Sirius Satellite Radio Inc.*, *Application for Special Temporary Authority to Operate Satellite Digital Audio Radio Service Complementary Terrestrial Repeaters*, Order and Authorization, 16 FCC Rcd 16773, 16779 (¶ 17) (2001). This interim process has proven to be inefficient, *see Sirius Satellite Radio,* File No. SAT-STA-20061107-00131 (filed Nov. 7, 2006) (application for four new terrestrial repeaters in Alaska and Hawaii pending since November 2006) while constraining network flexibility, *see Sirius Satellite Radio*, File No. SAT-STA-20080131-00034 (filed Jan. 31, 2008) (seeking modification of Sirius' Special Temporary Authority to increase the operating power of fifteen low-power satellite digital audio radio service terrestrial repeaters).

## I. INTRODUCTION AND SUMMARY

Satellite radio service is a Commission success story. Serving more than 16 million subscribers, Sirius and XM have invested billions in spectrum[3] and hardware to ensure that satellite-based transmissions of news and entertainment programming are available at a service availability level of more than 99 percent within the continental United States ("CONUS"). The FCC must ensure that continued success and service to millions of American consumers is not hampered by inefficient and unnecessary regulatory processes that impede the deployment of terrestrial satellite repeaters or by harmful interference from adjacent band operations.

The Commission issued this Notice seeking to finalize regulations for satellite radio terrestrial repeaters and simultaneously to consider changes to the rules governing operations in the WCS band. Specifically, the Commission requested comment on separate filings by Sirius and the WCS Coalition, each of which contained recommended modified rule provisions in Parts 25 and 27. The Commission also sought to update the record on a number of issues.

The time is long past for resolution of these issues. Sirius urges the FCC to finalize the satellite radio repeater rules it proposed almost eleven years ago. As the Commission has repeatedly recognized, terrestrial repeaters are needed to improve reception in areas where the satellite signals experience increased path loss, such as urban canyons or suburban areas with dense foliage. But while these areas currently represent less than one percent of CONUS, terrestrial repeaters are nonetheless an essential

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3 The corporate predecessors of both Sirius and XM acquired satellite radio licenses at auction for more than $173 million. *See* Press Release, *FCC Announces Auction Winners for Digital Audio Radio Service*, Public Notice, 12 FCC Rcd 18727 (1997).

component of satellite radio. Consistent with the flexibility provided to other licensees with exclusive use of wide-area spectrum, Sirius urges the Commission to grant "blanket authority" for satellite radio licensees to deploy terrestrial repeaters that conform to the FCC's technical standards.

With regard to compatibility with adjacent band WCS operations, the FCC's policies require WCS operators to protect adjacent channel satellite radio services – and the millions of consumers that they now serve – a determination long past challenge or appeal. The need to protect satellite radio led to the adoption of stringent technical standards for WCS operations that, in the FCC's opinion, "may make mobile operations in the WCS spectrum technologically infeasible." Choosing to ignore this history, the WCS operators are pursuing a series of technical rule changes to better facilitate the introduction of commercial mobile service while downplaying and ignoring any impact to satellite radio. In fact, WCS licensees are attempting to better their market position without demonstrating "interference protection equivalent to that afforded by the [current] limits" as the rules require.[4]

Specifically, WCS operators seek to alter how power is measured, envisioning unlimited deployment of WCS base stations with up to 2,000 Watt Effective Isotropic Radiated Power (EIRP) measured on an *average basis* (current Part 27 regulations are benchmarked to "peak" power).[5] In addition, the WCS operators propose a staggering 55 dB relaxation in the current out-of-band emissions ("OOBE") limit for WCS mobile

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4 *See* 47 C.F.R. § 27.53(a)(8) (2007).

5 *See id*. § 27.50(a).

devices. If adopted, these proposals would generate crippling interference to consumers' satellite radio receivers.

In contrast to the WCS Coalition's proposals, Sirius continues to support the recommendation originally presented in its 2006 White Paper[6]: namely, to eschew indirect regulation of transmitter power, antenna heights, and antenna gain, and instead adopt ground-level emission limits for terrestrial repeaters and WCS base stations. A ground-level emission limit will allow both WCS and satellite radio operators the flexibility to consider a number of operating parameters, including power, antenna height, down tilt and antenna pattern, balancing coverage build-out mindful of the relevant status and sensitivity of adjacent spectrum networks.

However, as further discussed below, Sirius has determined that certain modifications to its original proposal are necessary. Taking into consideration the spectrum use of the operators in both bands, as well as published WiMAX operating parameters that may be deployed by WCS operators, Sirius proposes a more restrictive ground-level emission limit for operations in the C and D blocks that are directly adjacent to satellite radio operations. In addition, Sirius has determined that operations in the WCS band need less protection than originally proposed and that satellite radio terrestrial repeaters can therefore operate at a less restrictive ground-level emission limit without significantly interfering with WCS operations.

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6 *See* White Paper: Interference to the SDARS Service from WCS Transmitters (attached to Letter from Carl R. Frank, Counsel to Sirius Satellite Radio Inc. to Marlene H. Dortch, Secretary, FCC, WT Docket No. 05-256 and IB Docket. No. 95-91 (filed Mar. 29, 2006)) ("Sirius White Paper").

As Sirius demonstrates in the attached technical appendices, WCS mobile stations operating at any appreciable power pose an extremely high risk of interference to satellite mobile receivers when in close proximity and, consequently, Sirius proposes technical limitations on mobile operations in the WCS band. Some of the WCS parties agree: the instant issue is almost identical to the interference scenario discussed in other proceedings, notably the proceeding considering service rules for the 2.1 GHz AWS-3 allocation.[7] The approach Sirius suggests is consistent with most of the technical analysis filed in that docket, including that of WCS licensees.

Finally, in order further to protect millions of existing satellite radio consumers, Sirius also recommends that the Commission grandfather its existing network of repeaters. Approximately 40 percent of these sites operate at 2,000 Watts or less effective isotropic radiated power (EIRP), a level recognized by WCS licensees as non-problematic.[8] The sites that operate with more than 2,000 Watts have been in operation for years and they are essential to providing quality service to subscribers. Their locations are well known, and they are unlikely to pose any interference risk to WCS operations.[9] The alternative of replacing high-power transmitters with scores of repeaters operating at lower powers would pose a greater risk of potential interference to WCS operations.[10]

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[7] *Service Rules for Advanced Wireless Services in the 2155-2175 MHz Band*, WT Docket No. 07-195, Notice of Proposed Rulemaking, 22 FCC Rcd 17035 (2007).

[8] *See* Exhibit B, Section 2.

[9] *See* Reply Comments of Sirius Satellite Radio, IB Docket No. 95-91 and GEN Docket No. 90-357, at 6-16 (filed Mar. 8, 2000).

[10] *See* Exhibit B, Section 1.

## II. SATELLITE RADIO REQUIRES AN EFFICIENT LICENSING SCHEME FOR TERRESTRIAL REPEATERS TO COMPLEMENT SATELLITE SERVICE TO MILLIONS OF SUBSCRIBERS

To protect the interests of satellite radio consumers, the Commission must adopt an efficient, permanent and easy-to-administer licensing system for satellite radio terrestrial repeaters. As the Commission has repeatedly recognized,[11] terrestrial repeaters are a complementary but essential component of satellite radio systems,[12] and satellite radio providers must finally have regulatory certainty about the licensing and operation of them in order to adequately plan future deployment and services.

Satellite radio's more than 16 million subscribers were attracted not only by the content that satellite radio offers, but also by its technical capability of providing continuous, nationwide, high-quality audio service – a service level that, in essence, would replicate or exceed the quality and availability of other competing platforms of audio entertainment options.[13]

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[11] The International and United States Frequency Tables both allow the use of complementary terrestrial broadcasting in the satellite radio band. *See* 47 C.F.R. § 2.106, Footnote 5.393 and Footnote US327. In addition, in the 1995 NPRM proposing satellite radio service rules, the Commission noted that some of the satellite radio applicants anticipated using terrestrial repeaters and requested comment on their use. Satellite Radio NPRM at 15 (¶ 55). Because of this historical recognition and the clear public interest benefits of using repeaters to providing a seamless service to subscribers, the Commission need not further consider any suggestion that repeaters should not be operated in the satellite radio band. *See* Notice ¶ 52.

[12] In addition, European operators implementing satellite digital media systems also require a network of terrestrial repeaters. *See, e.g.*, "Worldspace Italia & Telecom Italia sign deal to design / deploy terrestrial repeater network in Italy," Press Release (Jan. 16, 2007) available at http://www.worldspace.ae/english/prdetail.asp?id=00009&pg=02 (last visited Feb. 11, 2008).

[13] Satellite radio's market-based requirement to provide its customers with more than 99 percent service availability far exceeds the requirements for the services under consideration by the adjacent band WCS licensees. As shown in the attached Exhibit A, commercial WiMAX service is designed to provide only about 95 percent service

Providing this technical reliability is an extremely difficult and complex engineering feat, and terrestrial repeaters are an essential part of this task. Today, Sirius operates 140 repeaters at moderate powers in the lower 48 states;[14] the majority are operated below 4,000 Watts.[15] While terrestrial repeaters are essential to overcoming satellite coverage challenges within urban canyons or areas of dense foliage, their cumulative coverage area is less than one percent of the contiguous United States. Satellite transmissions are and will remain the primary mode of signal delivery to satellite radio subscribers; satellite radio is – first and foremost – a satellite service.[16]

Six years after Sirius commenced commercial operation, satellite radio terrestrial repeaters still must be individually applied-for and approved in an unwieldy and protracted process that hinders efficient deployment and operated only under restricted and unprotected conditions. As discussed in Section III below, the Commission should remedy this inefficient system by adopting flexible licensing that encourages investment while minimizing licensee and agency process.

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availability. This difference in service availability is not trivial and requires significant interference protection to the satellite based service. *See* Exhibit A at Section 1.2.1.

14 In contrast, the commercial wireless services (broadband PCS, cellular and SMR) have deployed approximately 200,000 cell sites nationwide. *Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services*, Twelfth Report, WT Docket No. 07-71, FCC 08-28 ¶ 2 (Feb. 4, 2008).

15 *See* Exhibit B, Section 2.

16 A more complete description of how the satellite radio system provides this seamless coverage and availability is provided in Section 1.2.1.1 of Exhibit A.

## III. THE COMMISSION SHOULD ADOPT BLANKET LICENSING AND MINIMAL RECORDKEEPING AND NOTIFICATION REQUIREMENTS

Because satellite radio providers have nationwide and exclusive use of the spectrum purchased at auction (eliminating any concerns about co-channel interference), the Commission contemplated a relatively simple regime for regulating satellite radio repeaters. Consistent with the Notice, Sirius recommends an efficient approach centered on two basic elements: (1) blanket, nationwide licensing of repeaters; and (2) minimal recordkeeping and notification requirements.[17]

From the start, the FCC proposed to authorize terrestrial repeaters on a blanket basis appurtenant to each Part 25 satellite radio spacecraft license.[18] Six years of experience with STAs amply has validated this intention. Even WCS licensees support blanket licensing[19]—which they already enjoy under Part 27.

As an adjunct to blanket licensing, the recordkeeping and notification rules proposed by Sirius will be sufficient to ensure that all affected parties have notice of adjacent band operations. Under Sirius' proposed rules, each satellite radio and WCS provider will maintain an Internet database containing all of the essential information about each deployed – and, at some point, planned – terrestrial repeater or base station.

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[17] Sirius previously proposed record-keeping and notification requirements in this proceeding. *See* Petition of Sirius Satellite Radio Inc. for Rulemaking, and Comments, IB Docket No. 95-91, GEN Docket No. 90-357, RM-8610 (filed Oct. 17, 2006) ("Sirius Petition for Rulemaking").

[18] *See Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band*, Report and Order, Memorandum Opinion and Order and Further Notice of Proposed Rulemaking, 12 FCC Rcd 5754, 5812 (¶142) (1997).

[19] *See* Comments of WCS Coalition, IB Docket No. 95-91, RM Docket No. 8610, at 17 (filed Dec. 14, 2001).

Each such licensee could access every database at any time to determine whether planned base station or repeater deployment would generate harmful interference to subscribers of existing networks. In addition, any licensee that experiences out-of-band interference would be able to use the databases to narrow the potential sources of that interference. The maintenance of these databases also should not impose too great a regulatory burden on providers, since the required information is minimal and *per force* established and recorded during deployment.

Sirius supports the agency's suggestion[20] that blanket licensed satellite radio repeaters be subject to the Part 15 equipment authorization process known as certification. Certification appears to be the appropriate equipment authorization process for the type of transmitter that Sirius deploys as terrestrial repeaters and would be consistent with the obligation already imposed on WCS transmitters.[21]

Sirius also agrees that satellite radio and WCS operators should comply with the environmental impact and radio frequency safety rules and with Part 17 of the Commission's rules regarding antenna structure clearance.[22] WCS and satellite radio operators could include any information regarding Environmental Assessments (including RF Safety issues)[23] on the technical database described above. The Notice observed that terrestrial paging and cellular transmitters over 1,640 Watts EIRP are subject to environmental evaluation,[24] and sought comments on environmental rules

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[20] Notice ¶ 43.

[21] *See* 47 C.F.R. § 27.51.

[22] Notice ¶¶ 40-44.

[23] *Cf.* 47 C.F.R. §§ 1.1307, 1.1310.

[24] Notice ¶ 41.

applicable to "very low power" satellite radio repeaters.[25] Sirius recommends that the FCC require routine environmental processing policies to outdoor repeaters operating in excess of 1,640 Watts EIRP and any indoor repeater operating in excess of 2 Watts EIRP.[26] Allowing two Watts for low power satellite radio repeaters would parallel Sirius's recommendations for power limits on fixed WCS subscriber devices[27] and should be sufficient for most in-building satellite radio applications.[28]

## IV. SATELLITE RADIO IS AND MUST REMAIN PROTECTED FROM HARMFUL INTERFERENCE FROM ADJACENT BAND WCS OPERATIONS.

### A. The Current Limitations On WCS Operations Were Adopted For Sound Reasons that Remain Applicable Today.

In 1995, the Commission allocated the entire 2310-2360 MHz band to satellite radio on a primary basis.[29] Before satellite radio service rules were finalized, however, Congress directed the Commission to make spectrum available at 2305-2320 MHz and 2345-2360 MHz for wireless services.[30] Following Congress's mandate, which was

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25 *Id.* ¶ 43.

26 Previously, Sirius proposed exempting indoor repeaters/WCS user units up to 10 Watts.

27 *See* Section V.A.3.

28 Sirius has provided maximum permissible exposure analyses in recent requests for lower power repeaters operating at trade shows. *See e.g.*, File No. SAT-STA-20071205-00170 at Exhibit C.

29 *See Amendment of the Commission's Rules with Regard to the Establishment and Regulation of New Digital Audio Radio Services*, Report and Order, 10 FCC Rcd 2310 (1995) ("Satellite Radio Allocation Order").

30 *See* Omnibus Consolidated Appropriations Act, 1997, Pub. L. 104-208, 110 Stat. 3009 (1996).

largely driven by budgetary rather than spectrum management considerations,[31] the Commission established the WCS band at 2305-2320 MHz and 2345-2360 MHz.[32]

As the Commission recognized at the time, allocating terrestrial services immediately adjacent to satellite operations can produce an exaggerated "near/far" interference scenario where the reception of relatively low power transmissions received from satellites thousands of kilometers away could easily be overwhelmed by nearby channel terrestrial emissions emanating from much closer.[33] But the FCC's 2.3 GHz band plan, laid out in the contemporaneous Satellite Radio and WCS Rulemakings in Spring 1997, neither ducked the question nor declared a tie. Rather, the Commission was quite explicit:

> We also recognize that the 2320-2345 MHz frequency band is the only spectrum specifically available for provision of Satellite DARS in the United States. Accordingly, if Satellite DARS in this spectrum is subject to excessive interference, the service will not be successful and the American public will not benefit from the service. In contrast, [terrestrial mobile service] can be provided in other spectrum currently available for use by services including cellular and PCS. Thus, should the potential for WCS operations to interfere with DARS prove to be greater when the systems are implemented than our analysis indicates, we would of course revisit this issue and make appropriate adjustments.[34]

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31 *See "WCS Auction Brings In $13.6 Million," Washington Telecom News,* April 28, 1997 (indicating that the federal budget for 1997 included an expectation that a certain level of income would result from the WCS auction).

32 *See Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service*, Report and Order, 12 FCC Rcd 10785 (1997) ("WCS Report and Order").

33 The near-far interference scenario occurs when a radio receives a stronger signal from a nearby, adjacent channel transmitter as opposed to its desired, distant transmitter. *See Service Rules for the 698-746, 747-762 and 777-792 MHz Bands*, Second Report and Order, 22 FCC Rcd 15289, 15372 n.506 (2007).

34 *Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service*, Memorandum Opinion and Order, 12 FCC Rcd 3977, 3992 (¶ 27) (1997) ("WCS MO&O").

Consistent with that policy, the FCC set strict limits on WCS operations for the express purpose of "protect[ing]…satellite DARS licensees from interference from WCS operations."[35] This was anything but casual: Before the WCS auction, the Commission specifically cautioned that the regulations could have "significant cost or service implications for WCS."[36]

The agency also understood that mobile WCS service user units could be expected to be in closer proximity to a satellite radio listener and thus could exacerbate interference to satellite radio receivers. To address this incompatibility, the FCC imposed appropriately strict technical conditions – in particular, tight out-of-band emission limits – on WCS mobile devices[37] with an exception for low power-low duty cycle "portable" systems.[38] Underscoring its deliberate decision making, the FCC forthrightly and unequivocally acknowledged that these restrictions may "make mobile operations in the WCS spectrum technologically infeasible."[39] Indeed, the agency went out of its way to "caution prospective WCS licensees…to carefully consider whether their anticipated uses and business plans can be successfully implemented under the additional technical and operational restrictions necessary to qualify for the lesser out-of-band emission limit."[40]

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35 WCS Report and Order at 10787 (¶ 3).

36 *Id*. at 10855 (¶ 138).

37 *See id*. at 10787 (¶ 3).

38 47 C.F.R. § 27.53(a)(9).

39 *See* WCS Report and Order at 10787 (¶ 3).

40 *See* WCS MO&O at 3979 (¶ 5) (1997) (warning potential WCS bidders that "wide area, full mobility systems and service such as those being provided or anticipated

Finally, the Commission twice considered previous, timely reconsideration requests seeking relaxation of some WCS technical limits.[41]

The results of the WCS auction and the *fixed* wireless deployment to date reflect the widespread understanding of the requirement for WCS operations to protect satellite radio consumers. The entire 30 MHz WCS spectrum was auctioned for under $14 million, and several licensees were acquired for $1.00.[42] WCS licensees successfully

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in the cellular and PCS bands are likely to be of questionable feasibility"). Such coexistence issues between adjacent services are well known, as described in the ITU's report on TDD/FDD coexistence and the WiMAX Forum's paper on coexistence. *See* Report ITU-R M.2030, "Coexistence between IMT-2000 time division duplex and frequency division duplex terrestrial radio interface technologies around 2600 MHz operating in adjacent bands and in the same geographical area," 2003; "Service Recommendations to Support Technology Neutral Allocations – FDD/TDD Coexistence," WiMAX Forum (Apr. 10, 2007) ("FDD/TDD Coexistence"). Both reports acknowledge the severity of "potentially crippling" mobile-to-mobile interference. FDD/TDD Coexistence at 21.

41 *See* WCS Report and Order; *Emergency Motion of the Wireless Cable Ass'n Int'l, Inc. for a Stay of the Wireless Commc'ns Serv. Auction and Associated Rules*, Order, 12 FCC Rcd 3974 (1997).

42 *See* Press Release, *WCS Auction Closes, Winning Bidders in the Auction of 128 Wireless Communications Service Licenses*, Public Notice, 12 FCC Rcd 21653 (1997) (noting that Auction 14, the WCS auction, "rais[ed] a net total of $13,638,940 for the U.S. Treasury"). *See also* George Gilder, *Don't Crush Wireless Innovation*, Wall St. J., Sept. 16, 1997, at A22 ("The so-called Wireless Communications Service auction in April saw licenses in St. Louis, Minneapolis, Milwaukee, Des Moines, Iowa, and Omaha, Neb., go for just $1 per person – a fraction of 1 percent of the value of previous licenses."). In fact, in each of these cases, winning bidders in the WCS auction paid only $1 for the *entire market*.

tested and promoted "fixed wireless broadband access" networks.[43] Apart from Metricom's deployment of a non-interfering wireless broadband network that failed commercially several years ago,[44] no WCS licensee has sought to provide mobile services at 2.3 GHz even though the Commission has adopted a mobile standard for a certain type of portable system.[45] Indeed, WCS operators may not even have sufficient spectrum to offer a mobile service, which underscores that the FCC's decision to protect satellite radio vis-à-vis WCS operations was correct and should not be changed.[46]

Today, fixed WCS equipment is certified under the FCC's equipment authorization process and is commercially available.[47] Some WCS licensees are building

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[43] *Evolution of the Wireless Cable Association*, Private and Wireless Broadband Magazine (Mar. 2000), http://www.broadbandproperties.com/2000%20issues/march/andy-kreig.htm (last visited Feb. 14, 2008).

[44] *See* Opposition of Sirius Satellite Radio, WT Docket No. 06-102, at 9 (filed June 9, 2006).

[45] The only portable WCS implementation the Commission accommodated was based on a particular low power technology (likely to be operated indoors) proposed by PPF/Digivox, which assumed a 0.2 Watt mobile transmitter and an 0.8 Watt base station with a 12.5 percent duty cycle. These low power levels suggest a local area network implementation, not a wide area implementation such as WiMAX commercial mobile broadband service. In any event, the FCC already considered low-power portables and already relaxed out-of-band limits for such units—only to 93 + 10 log (p), which is 38 dB more protective than what the WCS Coalition proposes to apply to WCS mobile devices operating with up to 2 Watts power. *See* WCS MO&O at 3991 (¶ 26); 47 C.F.R. § 27.53(a)(9). The Commission emphasized that it was necessary to know the technical parameters of that "specific WCS system" in order to determine whether it was appropriate to loosen the out-of-band emission requirements. WCS MO&O at 3991 (¶ 26).

[46] The WiMAX Forum has stated that "30-40 MHz spectrum allocation is needed to cost-effectively roll out a comprehensive suite of personal wireless broadband services." *See* "A Review of Spectrum Requirements for Mobile WiMAX Equipment to Support Wireless Personal Broadband Services", WiMAX Forum, at Section 6.5 (Sept. 2007).

[47] *See* Equipment Authorization FCC ID PL6-2300-BTS3-R1 (equipment authorization for Navini Networks base station transceiver operating in the 2305-2320

and deploying fixed wireless access WCS networks;[48] others may find market opportunities providing backhaul or other applications.[49] IEEE 802.16d WiMAX fixed wireless network systems are one possible use, especially in low density, underserved areas (*e.g.*, rural areas).[50] Such systems are technically similar to multipoint multichannel distribution[51] and – as Sirius predicted almost a decade ago[52] and confirmed in multi-party field testing[53] – pose little interference risk to satellite radio under the current rules.

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and 2345-2360 MHz bands); Experimental License No. 0187-EX-PL-2007 (experimental license of Horizon Wi-Com to test fixed wireless broadband service, utilizing Navini modem equipment). Alvarion BMAX-BST-AU-ODU-HP-2.3 Base Station for A/B blocks, FCC ID LKT-BMAX-BA23; Alvarion BMAX-CPE-ODU-PRO-SA-2.3 subscriber unit, FCC ID LKT-BMAX-SU23.

48 *See* Press Release, "AT&T Announces Availability of Fixed Wireless High Speed Internet Access in Pahrump," Nov. 16, 2006, http://www.att.com/gen/press-room?pid=4800&cdvn=news&newsarticleid=23161 (last visited Aug. 27, 2007) (announcing the availability of fixed wireless broadband service using 2.3 GHz spectrum in Pahrump, Nevada).

49 *See* Comments of Sprint Nextel Corporation, ET Docket No. 04-186 and ET Docket No. 02-380 at 4 (filed Aug. 15, 2007); Letter from Lawrence R. Krevor, Vice President, Government Affairs—Spectrum, Sprint Nextel Corporation and Thomas S. Sugrue, Vice President, Government Affairs, T-Mobile USA, Inc. to Marlene Dortch, Secretary, FCC (filed Jan. 3, 2008).

50 "Business Case Models for Fixed Broadband Wireless Access based on WiMAX Technology and the 802.16 Standard", WiMAX Forum White Paper, Oct. 10, 2004 at Conclusion 4, page 23.

51 Dan O'Shea, BellSouth Buy May Boost MMDS Prospects, TelephonyOnline.com, May 19, 2003 at http://telephonyonline.com/access/print/telecom_bellsouth_buy_may/index.html (last visited Feb. 6, 2007).

52 *See* Supplemental Comments of Sirius Satellite Radio, IB Docket No. 95-91, GEN Docket No. 90-357, at 10-11 (filed Jan. 18, 2000); Reply Comments of Sirius Satellite Radio, IB Docket No. 95-91 and GEN Docket No. 90-357, at 6-16 (filed Mar. 8, 2000).

53 Comments of XM, IB Docket No. 95-91, GEN Docket No. 90-357, at 6, Exhibit A (filed Dec. 14, 2001) (showing that a higher power XM repeater across the street from AT&T WCS CPE and 350 feet from an AT&T WCS base station did not cause interference).

The same cannot be said of cellularized mobile services such as WiMAX. These mobile broadband networks, if implemented as proposed, will introduce a totally different kind of base station deployment and radio link environment into the band than would exist with a simple expansion of current fixed wireless deployments.[54] The need for smaller cell sizes to accommodate weaker reverse link margins from portable and mobile devices (versus fixed deployments) will necessitate the use of much higher numbers of base stations than the fixed service would, at a lower average height and potentially with more use of antenna down tilt to control self interference.

The technical parameters imposed on WCS transmitters by the FCC were based on sound physics whose principles remain unchanged. Satellite radio operators relied on those policies and standards. Both satellite radio licensees designed, built and deployed their systems to withstand interference that could be anticipated from Part 27-compliant systems. It should be emphasized, therefore, that the satellite radio operators continue to require protection for receivers in satellite only coverage, conditions applicable over more than 99 percent of the U.S. land mass. The Commission should not undermine rational investment-backed expectations that guided, and were reflected in, the satellite radio and WCS auctions.

After 10 years of widespread spectrum warehousing, a Commission construction extension,[55] and despite the fact that the WCS Coalition previously stated that it "has *not*

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[54] *See* "Comparison of IEEE802.16 WiMAX Scenarios with Fixed and Mobile Subscribers in Tight Reuse", Siemens AG, C.F.Ball, IST Mobile and Communications Summit (June 2005).

[55] When the initial buildout period for WCS licensees had nearly been reached and almost no WCS equipment had been deployed, the Commission again provided regulatory relief, granting a construction extension on the basis that new technology

suggested that relief from the restrictive WCS spectral mask is necessary to permit deployments to move forward in accordance with their proposed extended construction schedule,"[56] WCS licensees want to abandon the rules and reverse the reasoning behind the 2.3 GHz bandplan. Yet, they supply no documentation or technical studies demonstrating how WCS mobile handsets operating in close proximity to satellite radio receivers could protect satellite radio operations.[57] While, as discussed below, the out-of-band emission limits for WCS mobile devices might be reduced somewhat if coupled with other rule changes, the potential for relief is very limited and nowhere near that proposed by the WCS Coalition.

### B. The WCS Coalition's Proposal to Operate Base Stations with up to 2,000 Watt EIRP and No Additional Technical Constraints Would Lead to Crippling Interference to Satellite Radio Over Wide Areas.

The WCS Coalition's proposal to change the present 2,000 Watt EIRP base station limit measured at peak power[58] to an average power standard, without additional technical constraints is not feasible. While simplistic in concept, the Coalition's proposal actually would require complicated rules and wide-ranging Commission oversight of,

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would allow WCS licensees to provide commercial service. *Consolidated Request for the WCS Coalition for Limited Waiver of Construction Deadline for 132 WCS Licenses,* Order, 21 FCC Rcd 14134, 14139-40 (¶¶ 10-12) (WTB 2006). Here again WCS requests regulatory relief, promising that this relief will finally result in construction and widespread commercial service. Reply Comments of the WCS Coalition, WT Docket No. 06-102 at 12 (filed June 23, 2006).

[56] Reply Comments of the WCS Coalition, WT Docket No. 06-102, at 12 (filed June 23, 2006).

[57] Further, as detailed below, the WCS Coalition never addresses how relaxing the out-of-band emission limits into the satellite radio allocation could satisfy the present Part 27 limits applicable to the next adjacent aeronautical telemetry band. *See* 27 C.F.R. § 27.53(a)(3).

[58] *See* 47 C.F.R. § 27.50(a)(1-2).

among other things, WCS antenna heights, patterns and down tilt. These standards, many of which have not yet been considered or proposed by the WCS licensees, would not be as practical as Sirius' proposed ground-level emission limit, discussed below.

More significantly, the 2,000 Watt average EIRP base station proposal would cause substantial interference to satellite radio reception over large geographic areas. Sirius and XM already have shown this in their September 2007 joint ex parte,[59] which modeled the potential for interference to satellite radio from two possible WCS deployments. *First*, the satellite radio operators modeled the interference from a single 2,000 Watt WCS base station operating two blocks from major highways (I-105 and I-110) in Los Angeles.[60] This single WCS base station would overload satellite radio reception within four to seven blocks of residential and commercial areas surrounding the site as well as on the nearby highways, blocking satellite radio reception to the thousands of cars that drive on these major roads daily.

*Second*, were WCS licensees to deploy a cellularized WiMAX system in Los Angeles, the result would be an overlapping patchwork of dead zones that would essentially block satellite radio reception throughout the city. The same effect would be replicated and spread throughout markets wherever the 2,000 Watt average transmit power base stations (proposed by the WCS Coalition) were operated, creating more significant interference conditions. The September 2007 analysis concluded that changing the base station power limit from 2,000 Watt peak transmit power to 2,000

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59 *See* Letter From Patrick Donnelly, General Counsel, Sirius Satellite Radio Inc. and James Blitz, Regulatory Counsel, XM Satellite Radio Inc. to Marlene Dortch, Secretary, FCC, IB Docket No. 95-91 and GEN Docket No. 90-357 (filed Sep. 19, 2007) ("September 2007 Ex Parte").

60 September 2007 Ex Parte at Annex 2, 4-9.

Watts average transmit power would at least quadruple the interference area around a base station for satellite radio receivers in satellite-only coverage.

Though the WCS licensees are likely to claim, as they have in the past, that satellite radio systems are sufficiently robust to accommodate the additional interference that would be created by these base stations, that simply is not the case. Satellite radio systems and consumer equipment were simply not designed to withstand this additional interference. In fact, the spatial diversity and buffering Sirius and XM have deployed are necessary to maintain the existing high-quality service required for a widespread consumer entertainment service like satellite radio and do not provide sufficient margin to repel the kind of interference the WCS Coalition proposes to introduce into the band.[61]

### C. The WCS Coalition's Proposal to Increase Out-of-Band Emissions to Facilitate Mobile Operations Would Result in Harmful Interference to Satellite Radio Receivers.

In addition to its unbounded 2,000 Watt average base station proposal, the WCS Coalition has proposed reducing the Part 27 minimum suppression of out-of-band emissions from mobile WCS subscriber units by 55 dB (from 110 + 10 log (p)[62] to only 55 + 10 log (p) in the adjacent band).[63] The WCS Coalition has admitted that this change is aimed at facilitating mobile operations in the band.[64] However, such out-of-band emission relief, if granted, would result in unacceptable mobile-into-mobile interference

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[61] Satellite radio operators sacrifice capacity and data throughput by retransmitting the same programming content three times (two satellite streams and one terrestrial path) in order to ensure high quality service.

[62] 47 C.F.R. § 27.53(a)(2).

[63] *See* Letter from Paul J. Sinderbrand, Counsel to WCS Coalition to Marlene Dortch, Secretary, FCC, IB Docket No. 95-91 and GEN Docket No. 90-357, at 9 (filed July 9, 2007) ("WCS Coalition July Ex Parte").

[64] *Id*. at 10.

even when the victim and interfering devices are separated by significant distances. Moreover, the WCS Coalition has not addressed how it could meet the relaxed standard in the satellite radio spectrum and still comply with limits on out-of-band emissions limits protecting aeronautical telemetry operations in the next adjacent band.[65]

Sirius has confirmed the significant potential for out-of-band emission interference through experimental testing. In Annex 1 of the September 2007 Ex Parte, Sirius and XM provided an analysis showing that the existing out-of-band emissions limit of 110 +10 log (p) dB protects satellite radio receivers at a separation of 3.3 meters or more, even when the satellite link margin is degraded, as would be the case if the satellite radio signal were impacted by foliage.[66] By contrast, when using the WCS Coalition's proposed emissions mask, the modeling showed that the separation distance necessary to mitigate WCS out-of-band emission interference to satellite radio receivers would increase to 860 meters for the 1dB threshold.[67] Sirius has since taken field measurements and found that the actual satellite noise floor is -113 dBm, 2 dB less than that used in the model.[68] This means that the actual interfering distance would be even greater than 860 meters.

The Commission cannot adopt the WCS Coalition's proposal to relieve out-of-band emissions to this degree in order to facilitate mobile use in the WCS bands without

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[65] 47 C.F.R. § 27.53(a)(3).

[66] *See* September 2007 Ex Parte, Annex 1.

[67] Sirius used a 1 dB rise in the noise floor as its threshold for receiver impairment, a measure that is generally accepted. *See* Exhibit A at 2.3.10; "COMPATIBILITY OF SERVICES USING WiMAX TECHNOLOGY WITH SATELLITE SERVICES IN THE 2.3 - 2.7 GHz AND 3.3 - 3.8 GHz BANDS", WiMAX Forum, 2007 Section 4.

[68] *See* Exhibit C, Appendix 1.

causing unacceptable interference to satellite radio. This is especially so because mobile use in the WCS band will lead to massive levels of overload interference to satellite radio receivers used by millions of consumers as described below and in Exhibit A of the attached Appendix.

### D. Mobile WCS Transceivers Would Cause Significant Interference to Satellite Radio Operations.

If WCS licensees deployed a WiMAX mobile system, mobile WCS transceivers would cause crippling interference to satellite radio receivers. Satellite receivers are attempting to receive satellite based transmissions originating from space platforms more than 48,000 kilometers in space that can be lower than -102 dBm. Given this relatively weak signal strength, it is imperative to minimize the amount of energy received from the adjacent WCS band.

Sirius' initial model in its September 2007 Ex Parte indicated that WCS mobile devices operating at up to 250 mW EIRP and with a reduced satellite link margin,[69] would cause overload interference that would degrade satellite radio reception within 115 meters of the interfering WCS devices, where one of the two satellite signals would be unusable. In addition, satellite receivers within 26 meters would be rendered unusable by interference that is high enough to mute both satellite signals. At the 2 Watt mobile transmit power proposed by WCS, these interference distances would triple.

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[69] *See* September 2007 Ex Parte at Annex 1. This modeling used signal-in-space characteristics consistent with equipment deployed in the nearby 2.5 GHz band, including WiMAX mobile terminals. Sirius needed to use generic WiMAX inputs published in public documents because the WCS Coalition has so far not supplied any WCS service characteristics.

Since release of the Notice, Sirius undertook "real-world" experiments to determine the impact of overload interference. These experiments are described fully in the attached Exhibit C, but essentially involved measuring the distances at which a prototype 250 mW WCS mobile transmitter would mute a satellite radio receiver in full view of the satellite and operating full, as opposed to reduced, link margin.[70] The results of these experiments reveal that Sirius' modeling is largely accurate and that mobile WCS transmitters would mute satellite radio receivers at great distances.

The following table summarizes the results of Sirius' experiments and is replicated in the attached Appendix.[71] It shows, for example, that a mobile WCS transmitter operating with 250 milliwatts in the WCS C block mutes satellite radios receiving full link margin transmissions at separation distances of 34 meters.[72] Even WCS mobile devices operating in the A and B blocks, which are further removed from the satellite radio allocation, pose an interference risk to satellite receivers at unacceptable separation distances – approximately 18 meters. These results confirm the incompatibility of WCS mobile service and satellite radio service and validate the Commission's original decision to discourage WCS mobile applications.

| Band-Duty Cycle | A-6% | B-6% | C-6% |
|---|---|---|---|
| TDM1 | 19.2 m | 18.3 m | 39.0 m |
| TDM2 | 19.2 m | 17.7 m | 34.4 m |

70 Exhibit C, Section 3.

71 Exhibit C, Table 2.

72 The interfering distance would increase if the satellite receiver were receiving satellite signals at lesser link margins.

Sirius' test results also minimize the value of power control on WCS mobile units to mitigate interference, as argued by the WCS Coalition.[73] Sirius' results demonstrate that a WCS mobile unit would need to operate with less than 10 milliwatts in the A and B blocks and less than 1 milliwatt in the C block to avoid muting satellite radio reception at a separation distance of 3 meters.[74] Sirius believes that it is impractical to develop wide area mobile networks with such minimal handset powers.[75]

Unless the WCS licensees can provide convincing evidence that their operations at the proposed technical levels will not cause harmful interference to satellite radio receivers (a showing that Sirius considers unlikely given the results of its testing), the Commission should not amend its rules to accommodate mobile operations. Sirius recognizes that accurate interference testing is difficult, particularly with the large number of variables that must be addressed. Sirius would be pleased to do joint interference testing with the WCS under FCC oversight to revalidate its results, particularly if WCS could provide appropriate WiMAX equipment. The FCC imposed out-of-band emission limits on WCS operation in order to protect satellite radio and the consumers that rely upon the service.[76] As demonstrated by these test results, the limits remain appropriate and necessary today as they were when first adopted.

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[73] WCS Coalition July Ex Parte at 11, 12-13.

[74] Exhibit A, Section 2.3.9.

[75] Information submitted in the AWS-3 proceeding suggests that 250 milliwatts is the reference power level for commercial mobile service. *See* Comments of Motorola, Inc, WT Docket No 07-195, at 5 (filed Dec. 14, 2007) ("Motorola AWS-3 Comments").

[76] *See* WCS Report and Order at 10787 (¶ 3).

## V. THE COMMISSION SHOULD MODIFY EXISTING OR ADOPT NEW EMISSION RULES FOR WCS AND SATELLITE RADIO OPERATIONS.

The Commission should modify existing or adopt new emission rules for WCS and satellite radio operations. As an initial matter, the FCC should recognize and adopt the one technical parameter that the parties have shown agreement on, namely a 75 + 10 log (p) out-of-band emission requirement for WCS base stations and satellite radio repeaters.[77] In addition, the Commission should adopt ground-level emission limits for terrestrial repeaters and WCS base stations. Finally, were the agency to reduce the maximum allowable power for WCS mobile devices, it can also provide the WCS licensees with some relief from the out-of-band emission limits.

### A. The Commission Should Adopt Sirius' Ground-Level Emission Limit Proposal With Modifications.

#### 1. The Use of Ground-Level Emission Limits Is the Best Solution to the Interference Issues Between WCS and Satellite Radio.

Sirius' proposal to apply a "ground-level emission limit"[78] for satellite radio terrestrial repeaters and WCS base stations is the most practical solution to the interference issues presented by the adjacent band operation of satellite radio and WCS. As described in the 2006 Sirius White Paper and above, EIRP limits alone are insufficient to ensure control of a blanket interference environment surrounding the transmitter.[79] A

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[77] *See* WCS Coalition July Ex Parte at 7.

[78] As the Commission correctly noted, the emission limit proposed by Sirius as a "power flux density limit" or "PFD limit" is more properly characterized as a "ground-level emission limit." *See* Notice ¶ 15 n.42.

[79] *See* White Paper: Interference to the SDARS Service from WCS Transmitters, attached to Letter from Carl R. Frank, Counsel to Sirius Satellite Radio Inc., to Marlene H. Dortch, Secretary, FCC, WT Docket No. 05-256 and IB Docket No. 95-91 (filed Mar.

model that employs EIRP limits must also utilize numerous other technical limits such as antenna height and gain to satisfy interference issues, creating a complex scheme that is less effective than ground-level limits and constrains flexibility for operators seeking to deploy facilities. Uncertainties relating to the physical environments (and associated path losses) that can potentially exist between a transmitter and a victim receiver require assumptions upon assumptions to even begin to contemplate the necessary EIRP and other accompanying technical limits.

Due to this uncertainty, ground-level emission limits, independent of the environment of the transmitter, offer more control of interference while allowing more flexibility in antenna placement and site design. Use of a ground-level emission limit negates the need for height or power requirements and provides the licensees with operational flexibility. Sirius and XM have previously proposed procedures for siting satellite radio and WCS transmitters using ground-level emission limits and further material is in the Exhibits. An important element in our proposal is the use of exclusion areas to take care of the normal abnormalities in siting caused by terrain, propagation and other factors, such as bodies of water and large highways. Thus, ground-level emission limits are the most appropriate tool to combat interference between satellite radio and WCS.

Moreover, considerable precedent demonstrates that ground-level emission limits are effective tools in mitigating interference.[80] Recognizing the benefits of ground-level

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29, 2006) ("2006 Sirius White Paper").

[80] *See, e.g.*, *Service Rules for the 698-746, 747-762 and 777-792 MHz Bands, Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911*

emission limits, the Commission imposed PFD limits in the 700 MHz band, stating that the "requirement that licensees meet a PFD limit at specified locations near their base stations when operating at higher power levels is less burdensome than a proposal requiring licensees to meet a measured signal level in all devices operating in the vicinity of their base stations and will create more certainty for new licensees as they implement their systems."[81] The Commission also stated, in the Lower 700 MHz context, that a "PFD standard will minimize the likelihood of adjacent channel interference to ground-based devices by effectively limiting the energy received by such devices to levels no greater than what they would receive from adjacent channel base stations operating at

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*Emergency Calling Systems, Section 68.4(a) of the Commission's Rules Governing Hearing Aid-Compatible Telephones, Biennial Regulatory Review - Amendment of Parts 1, 22, 24, 27, and 90 to Streamline and Harmonize Various Rules Affecting Wireless Radio Services, Former Nextel Communications, Inc. Upper 700 MHz Guard Band Licenses and Revisions to Part 27 of the Commission's Rules, Implementing a Nationwide, Broadband, Interoperable Public Safety Network in the 700 MHz Band, Development of Operational, Technical and Spectrum Requirements for Meeting Federal, State and Local Public Safety Communications Requirements through the Year 2010*, Report and Order and Further Notice of Proposed Rulemaking, 22 FCC Rcd 8064, 8102 (¶ 99) (2007) ("700 MHz Report and Order and Further Notice"). In fact, the Commission regularly imposes PFD limits and uses PFD data in its analysis of applications. *See, e.g.*, 47 C.F.R. § 25.208 (placing PFD limits on certain space stations); *see also* 47 C.F.R. § 25.114 (2006) (requiring PFD data in space station applications).

[81] *See* 700 MHz Report and Order and Further Notice, 22 FCC Rcd at 8102 (¶ 99). It should be noted that commenters in the 700 MHz proceeding, including AT&T, supported PFD limits in this context. *See, e.g.*, Comments of AT&T Inc., WT Docket No. 06-150, at 18 (filed May 23, 2007); *see also* Comments of Motorola, Inc., WT Docket No. 06-150, at 2 (filed May 23, 2007); Comments of Verizon Wireless, WT Docket No. 06-150, at 7 (filed May 23, 2007).

1 kW ERP or less."[82] This commitment to ground-level emission limits in the 700 MHz band has been reaffirmed by the Commission.[83]

Similarly, the FCC adopted PFD limits on ancillary terrestrial transmitters associated with mobile satellite systems to minimize the threat of interference to adjacent band satellite receivers located aboard aircraft on the ground.[84] The Commission protected satellite receivers by limiting the amount of energy that would be received by adjacent-band terrestrial transmitters at airports. This interference scenario is replicated in the 2.3 GHz WCS and satellite radio bands and therefore requires a similarly protective response in this rulemaking.

In short, the FCC has long recognized the benefits of managing interference through ground-level power limits – the core of Sirius' proposal – especially when

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82 *Reallocation and Service Rules for the 698-746 MHz Spectrum Band (Television Channels 52-59)*, Report and Order, 17 FCC Rcd 1022, 1064 (¶ 105) (2002) ("Lower 700 MHz Report and Order").

83 *See, e.g.*, *Reallocation and Service Rules for the 698-746 MHz Spectrum Band (Television Channels 52-59)*, 17 FCC Rcd 11613, 11625 (¶ 31) (2002) (leaving unaltered PFD limits adopted in the Lower 700 MHz Report and Order); *see also* 700 MHz Report and Order and Further Notice at 8102 (¶ 99) (reaffirming the value of PFD limits in the Lower 700 MHz band). Moreover, the Commission also recognized the equitable burden such limits impose on licensees in the BSS context, stating that an PFD limits are "relatively straightforward, and distribute[ ] the burden of coordination equitably among all parties." *See The Establishment of Policies and Service Rules for the Broadcasting-Satellite Service at the 17.3-17.7 GHz Frequency Band and at the 17.7-17.8 GHz Frequency Band Internationally and at the 24.75-25.25 GHz Frequency Band for Fixed Satellite Services Providing Feeder Links to the Broadcasting-Satellite Service and for the Satellite Services Operating Bi-Directionally in the 17.3-17.8 GHz Frequency Band*, Report and Order and Further Notice of Proposed Rulemaking, 22 FCC Rcd 8842, 8852 (¶¶ 19-20) (2007) ("BSS Service Rules Order").

84 *See Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands; Review of the Spectrum Sharing Plan Among Non-Geostationary Satellite Orbit Mobile Satellite Service Systems in the 1.6/2.4 GHz Bands*, Report and Order and Notice of Proposed Rulemaking, 18 FCC Rcd 1962, 2040 (¶ 154) (2003).

confronted with adjacent services that operate with great variances in operating power. The application of ground-level emission limits in the instant proceeding is also appropriate, and the Commission, consistent with past practices, should apply such limits as a means of mitigating interference between satellite radio and WCS licensees.

#### 2. The Commission Should Adopt a Modified Version of Sirius' Ground-Level Emissions Limit Proposal

In previous filings, Sirius proposed a ground-level emission limit of -44 dBm equivalent received signal power (100 dBμV/m) for both satellite radio repeaters and WCS base stations. After further testing and studies, Sirius has determined that this proposal did not adequately account for the potential for different levels of interference that might be experienced by satellite radio depending upon which block of WCS spectrum is being used to provide service, or to take into account the *de facto* guard band allocated to WCS terminals that arises from the spectrum use in the satellite radio band.[85]

Based on its recent field testing, it is apparent that a higher level of interference protection will be necessary in the WCS blocks immediately adjacent to the satellite radio allocation, the C and D blocks.[86] Specifically, while Sirius believes that its previously proposed 100 dBμV/m ground-level emission limit is appropriate for operation in the A and B, in order to protect satellite radio, a ground-level emission limit of 90 dBμV/m is necessary for operation in the C and D blocks when no guard band is present. Current

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85 *See* Exhibit A Section 2.1.2.

86 Though Sirius only considered the impact on satellite radio reception from operations in the WCS block directly adjacent to its operations (the WCS C block), Sirius anticipates that similar protections are necessary for XM, which operates directly adjacent to the WCS D block.

fixed wireless equipment implements a flexible range of guard bands to allow for operation in the C and D blocks.[87]

In addition, Sirius has determined that its previously proposed 100 dBμV/m ground-level emission limits is too restrictive for satellite radio terrestrial repeaters. First, because satellite radio terrestrial repeaters operate from the middle of satellite radio's spectrum allocation, from 2324.2-2328.3 MHz for Sirius terrestrial repeaters and from 2336.225-2341.285 MHz for XM terrestrial repeaters, WCS operations have *de facto* guard bands of over 4 MHz that protect them from any terrestrial repeater emissions. Second, WCS networks will not, in fact, require the same degree of protection as satellite radio receivers. Using published technical information regarding WiMAX receiver sensitivity and coverage signal strength data and assuming the same performance can be expected from a WCS receiver as current satellite radio receivers have (at the same frequency separation), Sirius has established that WCS receivers should tolerate an overload level of at least -35 dBm.[88] Consequently, interference analysis reveals that satellite radio terrestrial repeaters need only meet a ground-level emission limit of 110 dBμV/m in order to protect WCS operations.[89]

These proposed protection limits assume that a satellite radio receiver is in areas served exclusively by satellite coverage. The use of a receiver receiving only satellite signals is appropriate because the vast majority of satellite radio coverage is, as the name

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87 *See* Exhibit A, Appendix 1.

88 *See* Exhibit A, Section 1.2.3.2.

89 *See* Exhibit A, Section 2.1.2.1.

suggests, satellite based. Indeed, as described above, Sirius' terrestrial repeaters cover less than one percent of the landmass of the United States.

The Commission requested comment on the necessity of 16 db band pass filters for WCS receivers in order to mitigate interference from satellite radio. Though such filters might be necessary in some service deployments and were the focus of significant debate during the pendency of this proceeding, if WiMAX user terminals are designed in keeping with industry standards and best practices, they will likely achieve the necessary filtering of the satellite radio band without the imposition of a specific 16 db band pass filter. In any case, the Commission should not require any reimbursement to the WCS licensee's for filtering that will be necessary to deploy WCS service.

In its petition for rulemaking, Sirius put forth a method for developing predictive analyses to demonstrate that terrestrial repeaters and WCS base stations are operating within the ground-level emission limits. To further develop the technical background supporting the practicality of using and verifying ground-level limits, Sirius has provided in the technical exhibits more detailed recommendations for what such a predictive analysis would entail in order to avoid significant variance between predictive analyses carried out by different parties.[90]

### 3. Low Power and Existing Repeaters Should Not Be Subject to the Ground-Level Emission Limit.

In its Petition for Rulemaking, Sirius recommended that very low power repeaters and existing repeaters should not be subject to the ground-level emission limit requirements. With respect to very low power repeaters, to minimize the risk of harmful interference, Sirius proposes that only repeaters operating at 2 Watts EIRP or lower, not 10 Watts as discussed by the Commission in the Notice, be excluded from the ground-level emission requirements. In addition, Sirius proposes that fixed WCS user terminals operating at or below 2 Watts EIRP also need not be subject to the ground-level emission

90 *See* Exhibit A, Appendix 2.

limit, as long as they also meet the 75+10 log (p) out-of-band emission requirement.[91] Sirius proposes that WCS fixed user terminals operating under this exception implement power control and have a guard band for operation in the C and D blocks. Current equipment already implements these features.

### B. Mobile WCS Service Should Be Subject to Stringent Power Limits.

If the Commission determines that mobile WCS operations are in the public interest, it must establish technical rules that will protect satellite radio devices at reasonable distances and, in particular, at three meters or more away from satellite radios. In particular, the Commission must dramatically reduce the permissible power limits in the rules today, which allows 20 Watts peak EIRP mobile operations,[92] even below the proposed 2 Watts average EIRP proposed by the WCS Coalition.[93]

Sirius chose three meters as an appropriate separation distance for protection from mobile WCS devices because of the potential for mobile WCS devices to operate in close proximity to satellite receivers in automobiles or portable receivers in office, home, or public settings. Notably, this separation distance is significantly greater than separation distances considered reasonable in other contexts, and may result in substantial interference to satellite radio receivers in certain situations. For example, in the H-Block proceeding, the Commission requested comment on the potential for interference

[91] For this purpose, Sirius would define fixed WCS terminals as equipment that transmits only when it is connected to AC power directly, or through a transformer. A fixed station does not transmit when connected only to a battery, whether internal or external.

[92] 47 C.F.R. 27.50(a)(2).

[93] WCS Coalition July Ex Parte at 10.

between mobile devices at distances of two meters and one meter.[94] CTIA, an industry group to which some of the WCS licensees belong, commented on these proposals and noted that "[o]ne meter is often used as the appropriate protection radius in analyses like this one to assess interference protection levels."[95] In addition, in the pending AWS-3 proceeding several parties, including Verizon, T-Mobile, and Motorola all characterized one meter as an industry standard in considering mobile-into-mobile interference.[96] Sirius proposes a separation distance that is fully three times that considered reasonable in other mobile-into-mobile interference contexts. Clearly, Sirius' expectation that it will not experience interference at a distance of more than three meters cannot be considered controversial.

Based on this three meter separation distance, Sirius undertook experiments to determine the power limitations that would have to be placed on WCS mobile equipment in order to protect satellite radio receivers at three meters. Sirius' experiments reveal[97] that in the WCS A and B blocks a mobile EIRP of less than 1 milliwatt causes muting and in the WCS C block (no guard band) a mobile/portable EIRP of less than 0.1 milliwatt causes muting at a three meter distance under single satellite conditions. Sirius' power limit proposal is based on combining these real world results with laboratory data,

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94 *Service Rules for Advanced Wireless Services in the 1915-1920 MHz, 1995-2,000 MHz, 2020-2025 MHz and 2175-2180 MHz Bands Service Rules for Advanced Wireless Services in the 1.7 GHz and 2.1 GHz Bands*, Notice of Proposed Rulemaking, 19 FCC Rcd 19263, 19299 (¶91) (2004).

95 *See* Comments of CTIA, WT Docket Nos. 04-356, 02-253, at 13 n.42 (filed Dec. 8, 2004).

96 *See* Comments of Verizon Wireless, WT Docket No 07-195, at 6 (filed Dec. 14, 2007) ("Verizon Wireless AWS-3 Comments"); Comments of T-Mobile, Inc., WT Docket No 07-195, at 8 (filed Dec. 14, 2007); Motorola AWS-3 Comments at 5.

97 Exhibit C, Table 3.

path loss estimates as well as receiver overload performance[98] and current product mix, and Sirius proposes mobile EIRP limits 10 dB higher at 10 milliwatts for the A and B blocks and for C block with a suitable guard band and 1 milliwatt for C block with no guard band. These limits are consistent with the recommendations of several commenters – including WCS licensee NextWave – in the Commission's proceeding to establish service rules for its AWS-3 allocation.[99]

In conjunction with these power levels, it might be possible to provide some out-of-band emission relief to WCS providers and still protect satellite radio subscribers. Based on Sirius' calculations[100] and test results, the Commission could relax the existing out-of-band emission requirements to 103 + 10log(P) (-73 dBm equivalent power in a 1 MHz bandwidth), which would provide 7 dB of relief.[101] However, Sirius believes that it

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[98] Exhibit A, Section 2.3.9

[99] *See e.g.,* Reply Comments of NextWave Wireless, Inc., WT Docket No. 07-195, at 5 (filed Jan. 14, 2008) (indicating that AWS-3 mobiles would "be limited to an EIRP in the range of 5-10 dBm); *see also* Verizon Wireless AWS-3 Comments at 13 ("AWS-3 mobiles transmitting in the 2155-2165 MHz band would have to be limited to a power level of 0 dBm (1 mW) to avoid harmful interference to AWS-1 mobile receivers"); Comments of T-Mobile, WT Docket No. 07-195, at 6 (filed Dec. 14, 2007) ("T-Mobile AWS-3 Comments") (proposing to "limit AWS-3 mobile radios to a maximum transmit power of 17 dBm in the 2155 to 2170 MHz band").

[100] Exhibit A, Section 2.3.10.

[101] Sirius' recommended OOBE proposal is again consistent with levels proposed in the AWS-3 proceeding. *See e.g.,* Verizon Wireless AWS-3 Comments at Attachment A, page 18 ("[a]n AWS-3 OOBE limit of -75 dBm/MHz RMS in the 2110-2155 MHz band is needed to protect AWS-1 mobile receivers"); T-Mobile AWS-3 Comments at 6 ("attenuate out of band emissions from AWS-3 mobile radios (assuming a 17 dBm maximum output) by 87.3 dB or greater"); Motorola AWS-3 Comments at A-6 (filed Dec. 14, 2007) ("[a]t a 1 m separation these measurements indicate the call would be dropped for out-of-band emissions levels from AWS-3 devices of -64.6 dBm/100 kHz and -68.4 dBm/100 kHz").

is not possible to relax the out-of-band emission requirement by 55 dB as requested by the WCS Coalition.

These kinds of out-of-band emission restrictions are not unique to satellite radio. In fact, in other analogous contexts, WCS licensees have themselves proposed similar out-of-band emission limits. In the Commission's AWS-3 proceeding, several commenters supported showings that out-of-band emission limits in that band needed to be more restrictive than the WCS proposed out-of-band restrictions in this band. For example, Verizon proposed an out-of-band emission limit for AWS-3 operations that calculates to approximately 105 + 10 log (p)[102] and T-Mobile proposed an out-of-band emission limit of 95 + 10 log (p) to protect AWS-1 mobiles.[103] Notably, AT&T, a WCS licensee, stated that mobile AWS-3 operations would have to operate under strict power and out-of-band emission limits in order to ensure protection to AWS-1 and AWS-2 terrestrial mobile devices.[104]

## VI. THE GRANDFATHERING OF EXISTING SATELLITE RADIO TERRESTRIAL REPEATERS IS ESSENTIAL TO ENSURE THE CONTINUED SUCCESS OF SATELLITE RADIO

The Commission should grandfather existing satellite radio terrestrial repeaters such that they can continue to operate under present parameters. The grandfathering of existing satellite radio repeaters is fair and feasible. Unlike the WCS operators, satellite

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[102] Verizon Wireless AWS-3 Comments at attached AWS-3 Band Interference Analysis at 18.

[103] T-Mobile AWS-3 Comments at 9.

[104] *See* Comments of AT&T, Inc., WT Docket No. 07-195, at 5 and 8 (filed Jan. 14, 2008) (supporting showings by Verizon Wireless and T-Mobile that proposed heightened out-of-band emission limits and strict power limits for AWS-3 devices); Reply Comments of T-Mobile USA, Inc., WT Docket No. 07-195 (filed Jan. 14, 2008).

radio licensees have spent hundreds of millions of dollars to deploy terrestrial repeaters and have millions of subscribers who depend on repeaters to receive the diverse content that satellite radio provides. Requiring Sirius to turn down and replace, for example, 8,000 Watt repeaters with numerous lower-power repeaters would be an expensive undertaking with the potential to disrupt service to customers in the affected geographic areas.

Contrary to past assertions by the WCS licensees, Sirius does not operate an over-powered repeater network. Indeed, as the histogram in Exhibit B evidences, Sirius operates 70 percent of its repeaters below 4,000 Watts.[105] In addition, Sirius operates many of these repeaters at power levels lower than that authorized by STA.

The WCS Coalition's approach would force satellite radio licensees to add hundreds of lower-power repeaters, rapidly and at huge expense. It has been shown that building many low power repeaters to replace the coverage of a single high power site actually generates more interference for WCS.[106] On a national scale, such an undertaking would be practically impossible, would cost tens of millions of dollars to install new repeaters and operate the new and old systems in parallel, and could entail significant disruption to satellite radio subscribers as the old system was turned off and the new system tested and deployed – all without any showing that the existing repeaters

105 Exhibit B, Section 2.

106 Exhibit B, Section 1.

are a material problem to the deployment of WCS operations.[107] In fact, WCS receivers, if properly designed, should experience very low levels of overload from existing sites.

Finally, the interference that would be caused by the proposals the WCS Coalition makes to facilitate the deployment of WCS mobile services could not be overcome even if satellite radio operators were to spend tens of millions of dollars on a new repeater configuration. The investment by satellite radio to build and maintain their terrestrial networks was essential to serve customers and should be protected by the Commission through grandfathering.

## VII. THE COMMISSION SHOULD AVOID IMPOSING ADDITIONAL, UNNECESSARY RESTRICTIONS ON THE USE OF TERRESTRIAL REPEATERS

### A. The Commission Should Not Restrict How Satellite Radio Operators Feed Their Terrestrial Repeaters or Restrict the Operation of Terrestrial Repeaters to the Footprint of the Satellite Signal.

The Commission should dismiss any proposal to limit the manner in which satellite radio operators feed terrestrial repeaters. If satellite radio operators find it commercially feasible and necessary to feed repeaters using leased spectrum on non-satellite radio satellites, there is no logical reason for the Commission to prohibit them from doing so. In using leased spectrum, both the satellite radio provider and the lessee would be acting well within the confines of the Commission's rules, and there is no legitimate technical or legal reason to stop them from doing so.

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[107] Though any complaints about deployment of additional repeaters would be spurious, such a deployment would likely raise concerns by terrestrial broadcasters that satellite radio operators rely too heavily on terrestrial repeaters.

The Commission should also allow satellite radio operators to extend satellite radio service to U.S. consumers not in the footprint of the satellite radio satellite system by deploying terrestrial repeaters in these areas. Deployment of terrestrial repeaters in areas without satellite radio coverage is an efficient manner in which to extend the benefits of satellite radio service to unserved areas, including Alaska and Hawaii.[108] The Commission should encourage the extension of the benefits of satellite radio to all Americans.

### B. Sirius Has No Plans to Use Spot Beams or Terrestrial Repeaters to Insert Local Content.

The Commission requests comment on a number of issues related to local programming, including whether the Commission should prohibit the use of regional spot beams.[109] Sirius has no plans to use regional spot beams or terrestrial repeaters to broadcast locally originated programming in the current or next generation of its system; satellite radio's nationwide coverage is one of its greatest assets. Nevertheless, the Commission should not prohibit use of any particular technology.

### C. Satellite Radio Should Comply With International Agreements.

Sirius continues to support coordination with Canada and Mexico as contemplated under current international agreements. Indeed, the use of PFD limits in these international agreements supports Sirius' proposal to use ground-level emission limits in this context.

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108 Indeed, Sirius has applied for an STA to operate terrestrial repeaters in these areas. That STA has been opposed by terrestrial broadcasters. *See* File No. SAT-STA-20061107-00131.

109 Notice ¶¶ 54-55.

## VIII. CONCLUSION

The issues before the Commission in this proceeding have been pending for far too long. The Commission's concerns over adjacent band interference in the 2.3 GHz band and the rules adopted to avoid it were based on sound physics that have not changed in the intervening ten years. All of the interested parties require final rules, and Sirius has provided significant technical information in this submission that supports the adoption of its proposed rules. Furthermore, Sirius has shown that the WCS licensees' proposals will not solve the interference issues caused by the adjacent band operation of these services and may in fact exacerbate many of these problems. In order to bring an end to this long-running proceeding and to protect the interests of millions of satellite radio consumers, the Commission should adopt the proposals of Sirius, including the adoption of a ground-level emission limit and the grandfathering of existing repeaters.

<u>*/s/ Patrick L. Donnelly*</u>
Patrick L. Donnelly
Executive Vice President, General Counsel,
and Secretary
Sirius Satellite Radio Inc.
1221 Avenue of the Americas
36th Floor
New York, NY 10020

Richard E. Wiley
Robert L. Pettit
Carl R. Frank
Wiley Rein LLP
1776 K Street, NW
Washington, DC 20006
(202) 719-7000

*Attorneys for Sirius Satellite Radio Inc.*

February 14, 2008

# Exhibit A

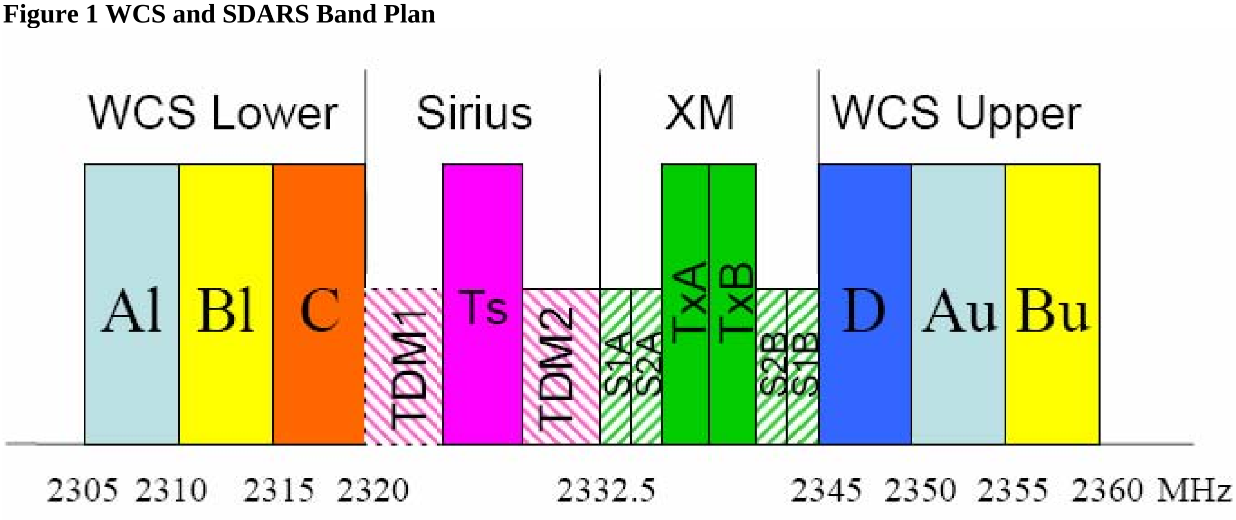
# Transmitter Power and Out of Band Emission Level Proposals for SDARS Repeaters, WCS Base Stations and User Terminals

# 1 Introduction

## 1.1 Band Plan

The WCS and SDARS services occupy 55 MHz of spectrum from 2305 MHz to 2360 MHz. The WCS service consists of six blocks of 5 MHz each, in the 2305-2320 MHz and 2345-2360 MHz bands. As shown in the following figure, there are paired blocks (A lower + A upper; B lower + B upper) that have been licensed on a regional basis (MEA service areas) and unpaired blocks (C and D) that have been licensed over very wide service areas (REAGs).[1] The SDARS service occupies the center 25 MHz (2320-2345 MHz) and is divided evenly between the two licensees, Sirius (2320-2332.5 MHz) and XM (2332.5-2345 MHz).

**Figure 1 WCS and SDARS Band Plan**




TDM1 = Lower band Sirius satellite channel
TDM2 = Upper band Sirius satellite channel
Ts = Sirius COFDM terrestrial transmission channel
TxA and TxB= Two sub-bands (ensembles) of XM terrestrial transmission channels
S1A and S1B= Two ensembles of XM's first satellite
S2A and S2B= Two ensembles of XM's second satellite

Originally, all but 5 MHz of the spectrum shown in Figure 1 was proposed to be used exclusively for SDARS. In 1990, the FCC issued a *Notice of Inquiry* soliciting information to be used in identifying spectrum and developing technical rules and regulatory policies for DARS in the United States.[2] In coordination with the National Telecommunications and Information Administration, the Commission supported U.S. efforts at 1992 World Administrative Radio Conference that ultimately allocated 2310-

[1] Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service ("WCS"), 12 FCC Rcd 10785, 10808 ¶ 45 (1997) ("WCS Report and Order").

[2] *Notice of Inquiry*, GEN Docket No. 90-357, 5 FCC Rcd 5237 (1990).

2360 MHz for satellite DARS, and complementary terrestrial repeaters, in the United States.[3]

## *1.2 Differences Between Broadcast SDARS Service and Two Way WCS Service*

### 1.2.1 Service and Network Requirements

#### 1.2.1.1 SDARS Service and Network Requirements

The SDARS service is a Mobile Satellite Service (MSS) serving the continental US and Canada. Operating in the highly competitive marketplace for broadcast entertainment, this low cost, subscription-based service requires very high levels of service link availability in order to ensure an almost uninterrupted listening experience, wherever the subscriber may be.

Unlike subscribers to two-way mobile communications services, in a (one-way) broadcast service such as SDARS, a customer has no capability to mitigate a service interruption (for example, by reinitiating a dropped call or waiting until a signal is available before placing a call.). Therefore *any* small interruption to the listening experience is significant from a consumer perspective.

The SDARS service, therefore, depends critically on maintaining higher levels of service availability than existing terrestrial-only mobile wireless communications services. Both SDARS operators have used a mixture of technological innovation, spatial and frequency redundancy to develop and maintain greater than 99% service availability throughout the continental US[4] and Canada. Recognizing that there are many locations that satellite signals may have difficulty being received, both SDARS operators augment the signal delivery with a small number of ground based repeaters in major cities. Sirius has deployed 140 repeaters to ensure that high availability levels are seamlessly achieved even in downtown areas with many tall buildings. The success of the SDARS hybrid satellite terrestrial architecture can be illustrated in contrasting the number of repeaters deployed to achieve greater than 99% availability (140) versus the approximately 30,000 base stations deployed by a typical nationwide cellular operator[5].

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[3] 47 C.F.R. § 2.106, international footnote S5.393.

[4] *See*, *e.g.*, Richard A. Michalski, Duy Nguyen, XM Satellite Radio, "A Method For Jointly Optimizing Two Antennas In A Diversity Satellite System**,"** AIAA-2002-1996 (2002).

[5] In its most recent report on the competitive market conditions for commercial wireless services, the FCC provided data showing more than 200,000 cell sites deployed nationwide for broadband PCS, cellular and SMR service. It is logical to assume that the four nationwide carriers have deployed a majority of these sites. *See Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services*, Twelfth Report, WT Docket No. 07-71, FCC 08-28 ¶ 2 (Feb. 4, 2008).

In augmenting the satellite delivery system, the SDARS repeaters cover less than 1% of the US land area, illustrating that the service is overwhelmingly delivered through satellite. This is highlighted in the following map of Sirius service in the Boston market, Figure 2, where the highway coverage shown in yellow is satellite only, and those roads in green are a mixture of satellite and repeater delivery. Similarly, in Figure 3, the overall areas are contrasted in yellow for those where only the satellite signals are available, and green where a mix of signals is present. Sirius currently uses only a single repeater in the Boston market.

**Figure 2 Comparison of Satellite and Repeater Highway Coverage for the Boston Market**

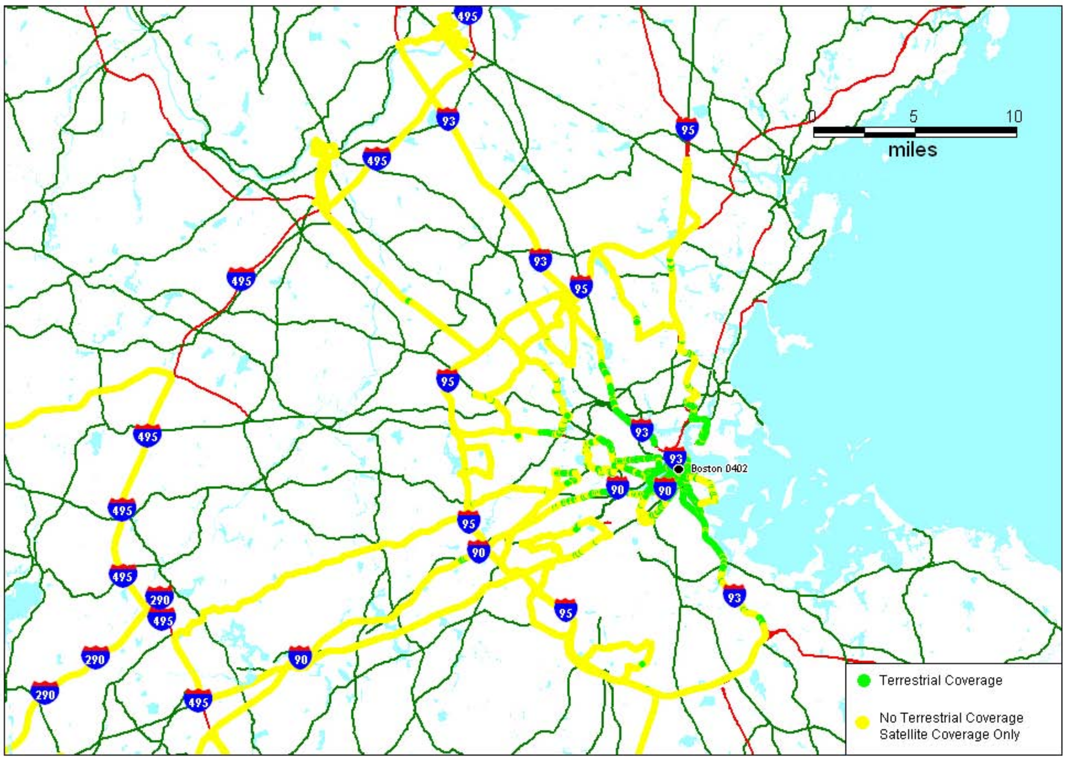
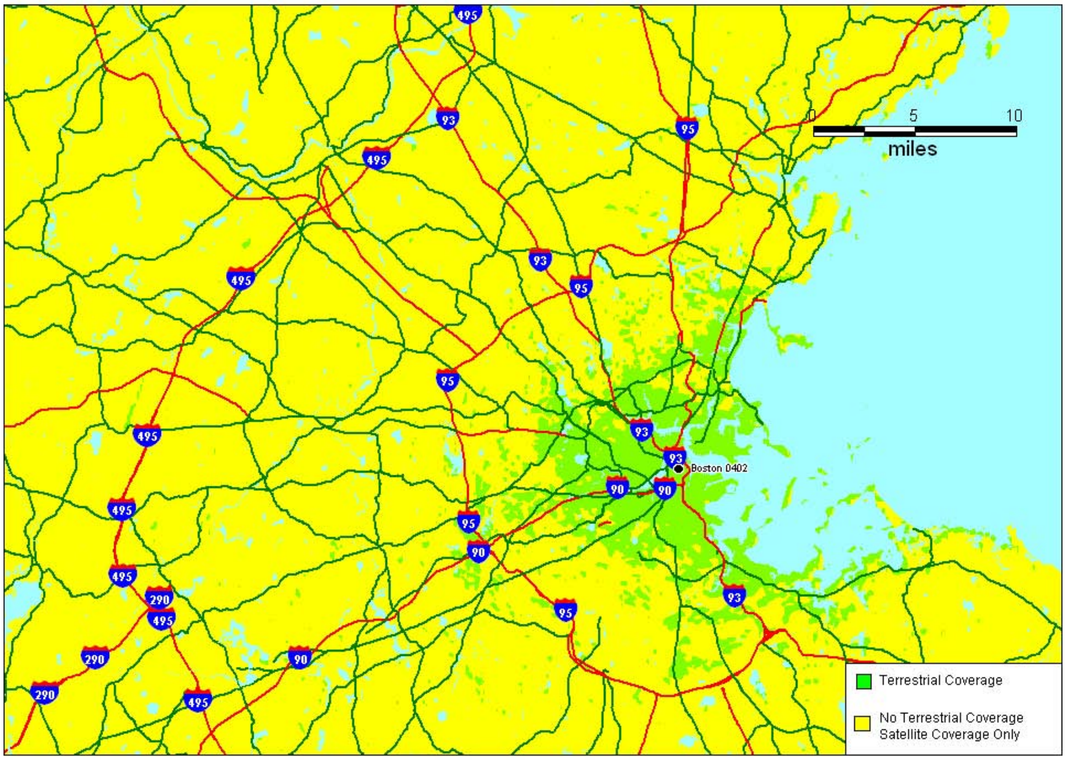


**Figure 3 Comparison of the Satellite And Repeater Area Coverage for The Boston Market**




The continuing success of the SDARS network in both ensuring seamless nationwide coverage while keeping subscription fees low, critically depends on maximizing the use of satellite infrastructure as opposed to terrestrial infrastructure with its associated higher operating costs. From a spectrum standpoint, this translates into maintaining a well understood adjacent band signal environment which minimizes degradation to the primary satellite signal reception from overload, intermodulation distortion ("IMD"), or out-of-band-emissions. Therefore, the primary concern addressed in this material is the impact of the proposed changes in Part 27 rules to allow WCS operators to transition from the successful fixed wireless access usage model upon which the original band plan was predicated to the more lucrative broadband mobile wireless model more normally associated with different band plans to the current WCS.

### 1.2.1.2 WCS Service and Network Requirements

There are two network types that are relevant in this discussion of the WCS band, namely fixed wireless access and mobile/ portable broadband.

#### *1.2.1.2.1 Fixed Wireless Access*

The networks that were originally considered to operate in the 2.3 GHz WCS band are fixed wireless, point to point or point to multipoint systems. These networks are similar in structure to the SDARS repeater network in that they consist of lower density, centralized, relatively high powered, tall transmitter sites with little or no antenna down tilt utilizing fixed user terminals with external or internal antennas. Several networks of this type are currently deployed and are successfully coexisting with SDARS service. The availability target for these types of networks is almost as high as for SDARS (in excess of 99%), but the coverage areas are typically market based as opposed to the SDARS national footprint.

#### *1.2.1.2.2 Mobile/Portable Broadband*

Mobile broadband services have significantly different network and terminal characteristics from fixed systems.[6] As contrasted with the previously described fixed network architecture, the network to support mobile service will typically consist of many more base stations (because of the weaker user terminal reverse link and the localized and dense traffic requirements) which may be lower in height and routinely implement antenna down tilt as a self-interference control mechanism. In addition, a high density of mobile terminals operating at significant EIRP's are used. As contrasted to fixed terminals, mobile/portable units would have uncontrolled proximity to SDARS users.

Because of the architecture and use differences of these mobile broadband services, it can be anticipated that the eventual coverage availability will be in the 95% range, which is significantly less than in the fixed wireless or SDARS case.[7]

## 1.2.2 Transmitter Requirements

### 1.2.2.1 SDARS Transmitter Requirements

SDARS transmitters are low volume platforms with an emphasis on moderate power design and "extreme" adjacent channel and out of band emission specifications. Significant cost and effort has gone into reducing the adjacent channel and out-of-band-emissions of these transmitters to improve the quality of the immediately adjacent satellite signals (*see* Figure 1). The current generation of Sirius repeaters were designed to meet a 75+10log(P) attenuation mask (where P is the **EIRP** in watts) and includes an additional margin of 15 dB to account for antenna gain. The equivalent transmitter output referenced specification would then be **90+10log(P)** (where P is the **transmitter output** power in watts). The allowed transmitter output power for an existing SDARS repeater, outside of the SDARS band, is therefore -60 dBm in a 1MHz bandwidth.

### 1.2.2.2 WCS Base Station Transmitter Requirements

A number of vendors, such as Alvarion and Navini, supply base stations for use in the 2.3 GHz band A, B, C and D blocks. This equipment uses either a proprietary airlink format

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6 C.F.Ball *et al*, Siemens AG, "Comparison of IEEE802.16 WiMAX Scenarios with Fixed and Mobile Subscribers in Tight Reuse," IST Mobile and Communications Summit (June 2005).

7 *See*, LCC International, Inc., *H Block MS Overload Analysis*, (Dec. 1, 2004), *available in* Comments of Nextel Communications, Inc., WT Docket No. 04-356 (Dec. 8, 2004), Introduction.

or, more recently, IEEE 802.16d WiMAX based equipment. From the equipment certifications available for review on the FCC's web site, it can be determined that it is technically and commercially feasible to meet the existing out-of-band-emissions for base stations of 80+10log(P) or -50 dBm in a 1MHz bandwidth at the transmitter output. This is 10 dB less stringent that for current SDARS repeaters. The vendors use innovative techniques, such as a variable guard band, to allow the maximum possible throughput in the C and D blocks, while meeting the appropriate out of band limits, Appendix [1] to the exhibit, illustrates the adjacent block operation of one of these devices in the C block and clearly shows the variable guard band feature.

#### 1.2.2.3 .WCS Fixed User Terminal Transmitter Requirements

Similarly, a number of vendors, such as Alvarion and Navini, supply fixed user terminals for both indoor and outdoor use in the 2.3 GHz band A, B, C and D blocks. This equipment either uses a proprietary airlink format or, more recently, IEEE 802.16d WiMAX based equipment. Power control is a typical feature. From the equipment certifications available for review on the FCC's web site, it can be determined that it is technically and commercially feasible to meet the existing out-of-band-emissions for these terminals of 80+10log(P) or -50 dBm in a 1 MHz bandwidth for all the WCS blocks, including the C and D blocks. As with the base stations, the vendors use innovative techniques, such as a variable guard band to allow the maximum possible throughput in the C and D blocks, while meeting the appropriate out of band limits.

#### 1.2.2.4 WCS Mobile User Terminal Transmitter Requirements

Sirius is not aware of any mobile terminals currently available that meet the existing specifications for the 2.3 GHz WCS band.

### 1.2.3 Receiver Requirements

#### 1.2.3.1 SDARS Receiver Requirements

SDARS receivers are designed to allow mobile reception of relatively weak satellite signals (from 48,000 km in space) as well as taking advantage of any available repeater signals. In order to receive the satellite signals, whose levels can be as low as -102 dBm, the satellite receiver must be more sensitive than a typical terrestrial mobile receiver. The receiving noise floor for an SDARS receiver has been measured at -113 dBm (in the 4MHz satellite bandwidth used).[8] The receiver types fall into a variety of categories including factory and aftermarket installed in cars, and portable. While the detailed performance of these radios varies by product generation, they all are required to process a wide dynamic range of signals in order to realize the system availability described above in 1.2.1.1.

[8] *See* Exhibit C, Appendix 1.

### 1.2.3.2 WCS User Terminal Receiver Requirements

A number of vendors, such as Alvarion and Navini, supply fixed user terminals for both indoor and outdoor use in the 2.3 GHz band A, B, C and D blocks. This equipment either uses a proprietary airlink format or, more recently, IEEE 802.16d WiMAX based equipment.

One way to estimate the overload performance of WCS terminals, fixed or mobile, is to compare the protection level required in terms of the difference in signal level between the wanted signal level and the interfering signal level as a function of the frequency separation between the two signals.

For the WCS B lower block, there is a 5 MHz frequency separation between the block and the Sirius TDM1 signal. The test results for the Sirius receiver using a 99% duty cycle WiMAX signal, which is similar to the continuous OFDM transmit signal used by the SDARS repeater, show an approximate 60 dB protection level (-100dBm wanted satellite signal on the ground and -40dBm interfering signal).

The worst case frequency separation between the SDARS repeater signal and the closest WCS frequency block is ~4 MHz away so a similar level of protection capability is reasonable to assume for the WCS receiver of 60 dB.

Given the lack of a 2.3 GHz WiMAX hardware platform, Sirius has looked at other references to understand the WiMAX receiver sensitivity. In these documents (*see* Table 1 below) the consumer unit receiver sensitivity level sited is -95.2 dBm. If one assumes a receiver implementation similar to an SDARS receiver that provides 60 dB of protection to an interferer that is 5 MHz away this means that all WCS receivers should be protected from a SDARS interferer up to a power level of approximately **-35 dBm**.

**Table 1 Wimax Link Budget**[9]

**Table 2.8** Sample Link Budgets for a WiMAX System

| Parameter | Mobile Handheld in Outdoor Scenario | | Fixed Desktop in Indoor Scenario | | Notes |
|---|---|---|---|---|---|
| | **Downlink** | **Uplink** | **Downlink** | **Uplink** | |
| Power amplifier output power | 43.0 dB | 27.0 dB | 43.0 dB | 27.0 dB | A1 |
| Number of tx antennas | 2.0 | 1.0 | 2.0 | 1.0 | A2 |
| Power amplifier backoff | 0 dB | 0 dB | 0 dB | 0 dB | A3; assumes that amplifier has sufficient linearity for QPSK operation without backoff |
| Transmit antenna gain | 18 dBi | 0 dBi | 18 dBi | 6 dBi | A4; assumes 6 dBi antenna for desktop SS |
| Transmitter losses | 3.0 dB | 0 dB | 3.0 dB | 0 dB | A5 |
| Effective isotropic radiated power | 61 dBm | 27 dBm | 61 dBm | 33 dBm | $A6 = A1 + 10\log_{10}(A2) - A3 + A4 - A5$ |
| Channel bandwidth | 10MHz | 10MHz | 10MHz | 10MHz | A7 |
| Number of subchannels | 16 | 16 | 16 | 16 | A8 |
| Receiver noise level | −104 dBm | −104 dBm | −104 dBm | −104 dBm | $A9 = -174 + 10\log_{10}(A7*1e6)$ |
| Receiver noise figure | 8 dB | 4 dB | 8 dB | 4 dB | A10 |
| Required SNR | 0.8 dB | 1.8 dB | 0.8 dB | 1.8 dB | A11; for QPSK, R1/2 at 10% BLER in ITU Ped. B channel |
| Macro diversity gain | 0 dB | 0 dB | 0 dB | 0 dB | A12; No macro diversity assumed |
| Subchannelization gain | 0 dB | 12 dB | 0 dB | 12 dB | $A13 = 10\log_{10}(A8)$ |
| Data rate per subchannel (kbps) | 151.2 | 34.6 | 151.2 | 34.6 | A14; using QPSK, R1/2 at 10% BLER |
| Receiver sensitivity (dBm) | −95.2 | −110.2 | −95.2 | −110.2 | $A15 = A9 + A10 + A11 + A12 - A13$ |
| Receiver antenna gain | 0 dBi | 18 dBi | 6 dBi | 18 dBi | A16 |
| System gain | 156.2 dB | 155.2 dB | 162.2 dB | 161.2 dB | $A17 = A6 - A15 + A16$ |
| Shadow-fade margin | 10 dB | 10 dB | 10 dB | 10 dB | A18 |
| Building penetration loss | 0 dB | 0 dB | 10 dB | 10 dB | A19; assumes single wall |
| Link margin | 146.2 dB | 145.2 dB | 142.2 dB | 141.2 dB | $A20 = A17 - A18 - A19$ |
| Coverage range | 1.06 km (0.66 miles) | | 0.81 km (0.51 miles) | | Assuming COST-231 Hata urban model |
| Coverage range | 1.29 km (0.80 miles) | | 0.99 km (0.62 miles) | | Assuming the suburban model |

9 *See* "2.7.2 Sample Link Budgets and Coverage Range (Cont)," *at* http://www.wimax.com/commentary/wimax_weekly/2-7-2-sample-link-budgets-and-coverage-range-cont (last visited Feb. 14, 2008).

# 2 Establishing Appropriate Power and OOBE Levels

## *2.1 SDARS Repeaters, Base Stations*

### 2.1.1 Introduction

The negative implications of the WCS Coalition's proposal to allow 2 kW blanket licensing of transmitters without additional constraints were discussed in Sirius and XM's previous ex parte filing.[10] The material presented here expands on that discussion with the objective of establishing appropriate power and out of band emission limits for WCS base stations and SDARS repeaters.

### 2.1.2 SDARS Repeaters and WCS Base Station Power Levels

It has been previously demonstrated that SDARS repeaters and WCS fixed wireless systems can coexist under the existing rules[11]. Such WCS fixed wireless installations generate well understood interference geometries and are similar to the SDARS repeater network in terms of the architecture.

Sirius has shown in a previous filing that ground based limits offer the most effective solution in controlling inter-band interference between SDARS and WCS[12]. Expanded information regarding the proposed use of predictive tools in the application of ground based limits is provided in Appendix [2] of this exhibit.

In order to be effective such limits must directly relate to the actual impact on the user terminal which, in the case of SDARS receivers, varies by WCS block (*see* Exhibit [C], Section III). For example, the SDARS receiver performance is significantly degraded for an interfering signal in the C block. This is due to the absence of any guard band between this block and the lower SDARS satellite channel, TDM1, significantly reducing the effectiveness of any practical receiver filtering.

Sirius therefore proposes to modify its original proposal (which was based on some form of guard band for the C block as is currently implemented in WCS fixed wireless equipment as shown in Appendix [1] to this exhibit) into two distinct ground based limits, one for the A and B blocks and one for the C and D blocks. This approach recognizes the reality that there is no guard band between the C block and the Sirius SDARS allocation (similarly for the D block and XM). This key issue of the lack of a

10 Sirius and XM, *Ex Parte* Presentation, IB Docket 95-91 (filed November 30 2007).

11 *See* Comments of XM Radio Inc., IB Docket No. 95-91, Exhibit A (filed December 14 2001).

12 Sirius and XM, *Ex Parte* Presentation, at Annex 2 (filed December 5, 2007).

guard band is very similar to the interference scenario discussed by several parties in the FCC's AWS-3 proceeding.[13]

Sirius has not been able to obtain detailed WCS mobile receiver data that would help further refine the Sirius proposal for limits for SDARS repeaters. However, an estimate of the expected overload levels of mobile WCS terminals can be made to be used in establishing the associated ground based level proposal for SDARS repeaters. This approach is based on assuming that WCS terminals have similar performance limits to SDARS receivers.

#### 2.1.2.1 Proposed Power Limits for SDARS Repeaters

Based on the analysis of expected WCS mobile receiver performance (*see* Section 1.2.3.2), Sirius is proposing a ground based power limit for SDARS repeaters of 110 dBµV/m (-35 dBm equivalent isotropic received power). The appropriate bandwidth for this measurement would be 4 MHz in the case of Sirius. The measurement would be average power and consistent with the measurement procedures outlined in Section 3. These repeaters would be subject to FCC Certification.

Sirius proposes that repeaters at 2W EIRP or below are exempt from the ground based limits proposed here. Such repeaters, however, would be subject to the FCC's equipment authorization Certification program.

#### 2.1.2.2 Proposed Power Limits for WCS Base Stations

Based on the satellite radio system design requirements as a result of the original 2.3 GHz band licensing and coordination rules and the measured performance of SDARS receivers (*see* Exhibit C), Sirius is proposing the following ground based power limits for WCS base stations:

- A, B blocks 100 dBµ/m (-44 dBm isotropic equivalent power)
- C ,D blocks 90 dBµV/m (-55dBm isotropic equivalent power)

These field strengths would be established for the nominal WCS channel signal bandwidth (i.e. 5 MHz), and measured at 2 meters AGL. These values, Sirius believes, represent a reasonable compromise between the scale of receiver performance degradation that Sirius can accept and the need for WCS operators to provide adequate coverage.

Appendix [3] provides some simplified insight into the potential application of these rules and their impact on the transmitter power/height/down tilt trade space. Tables are provided showing the predicted field strength level as a function of distance from a base station at a variety of antenna heights. Two different down tilt situations are modeled (1 degree, representing an example value for a fixed wireless base station and 10 degrees for

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[13] *See e.g.*, Reply Comments of AT&T Inc., WT Docket 07-195, at 5-6 (filed January 14, 2008).

a mobile base station) using a simple free space path loss model, together with the ITU-F1336 antenna model for a 90 degree sector antenna[14]. The EIRP chosen is 2,000 watts and the distance is predicted out to 1 km. Beyond 1 km, the site specific clutter is likely to reduce the applicability of the free space model. Within a 1 km radius, it serves to illustrate the relationships between the various parameters.

The general trend of areas exceeding the 100 dBµV/m limit are clear from these tables, namely, for the case of 1 degree down tilt, an antenna height of 50 meters or above essentially meets the 100 dBµV/m limit without exception at 2 kW. In practice the propagation loss would be expected to be greater than free space as the distance from the site increased and so the 30 meter antenna height case would most likely also meet the limit as the distance from the site at which the limit is exceeded with the simple free space model is greater than 850 meters.

Another general trend that can be discerned is that, at a given down tilt and power, as the height is increased, the area where the limit is exceeded moves further out from the base station and "flattens out", *i.e*. the taller the site the more likely that additional excess path loss will further reduce the ground field strength level.

The dramatic effect of increased down tilt is seen in the 10 degree down tilt table. The effect here at lower antenna heights is to move the area where the limit is exceeded closer to the base station where the probability of excess path loss due to clutter is less. In these circumstances, power and / or down tilt would have to be adjusted for compliance, depending on how exclusion zones are allowed for.

In practice, the actual predictions would use more accurate and sophisticated network planning tools, as described in more detail in Appendix [2] to this exhibit.

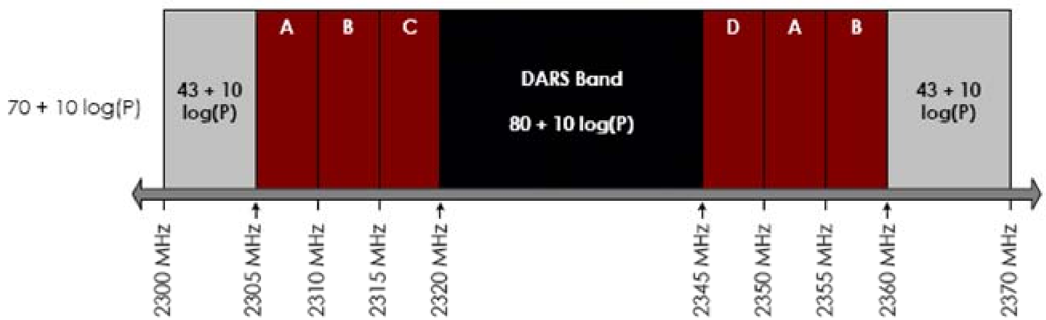
### 2.1.3 SDARS Repeaters and WCS Base Station Out-of-Band-Emissions Limits

#### 2.1.3.1 Introduction

The current out-of-band-emissions limits for WCS base stations are illustrated in Figure 4 Note that the out-of-band-emissions limits for SDARS repeaters currently exceed the 80 + 10 Log (P) (-50 dBm equivalent power) by 10 dB due to the SDARS requirement for additional margin to take into account antenna gain.

[14] ITU F1336, *recommends* 3.2, with improved side lobe performance.

**Figure 4 Out-of-Band-Emissions for WCS Fixed Services**[15]




### 2.1.3.2 Proposed Limits for SDARS Repeater Out-of-Band-Emissions

Sirius and the WCS Coalition agree on relaxing the out-of-band-emissions limit for SDARS repeaters and WCS base stations[16], specified at the transmitter output.

Sirius is therefore proposing an out-of-band-emission specification of 75 +10 Log (P) for SDARS repeaters, where P is the transmitter output power in watts. This is equivalent to a transmitter output power level of -45 dBm. The measurement bandwidth is 1 MHz and the measurement type is average power. This would also apply to SDARS repeaters operating at 2 W EIRP or less. This limit is measured at the transmitter output and needs to take into account the measurement requirements outlined in Section 3.

### 2.1.3.3 Proposed Limits for WCS Base Station Out-of-Band-Emissions

Sirius is proposing an out-of-band-emission specification of 75 +10 Log (P) where P is the transmitter output power in watts. This is equivalent to a power level of -45 dBm. The power measurement bandwidth is 1 MHz and the measurement is average power, subject to the burst measurement requirements outlined in Section 3.

[15] The graphic was originally included in an application for equipment authorization submitted by Navini Networks in 2006. *See* application for FCCID No. PL6-2300-BTS3-R1 *available at* https://fjallfoss.fcc.gov/oetcf/eas/reports/GenericSearch.cfm.

[16] *See* WCS Coalition Ex Parte, IB Docket 95-91, at 6 (filed Nov. 14, 2007).

## *2.2 WCS User terminals*

### 2.2.4 Introduction

### 2.2.5 Fixed WCS User Terminals

Sirius has established that current fixed wireless deployments and equipment certifications of WCS fixed user terminals (utilizing innovative guard band implementations in "C" block) present little issues for SDARS operations in their current form. Accordingly Sirius is proposing exemption from the ground based limits requires for such devices operating within EIRP limits and is supporting a relaxation of 5 dB in the out of band limits that such devices need to meet. Sirius believes this should further allow cost reductions in fixed user equipment, thereby further facilitating fixed wireless deployment in underserved rural markets.

### 2.2.6 Proposed Power Limits For Fixed User Terminals

Sirius proposes that a fixed user terminal be defined as:

*Equipment which transmits only when it is connected to AC power directly, or through a transformer. A fixed station does not transmit when connected only to a battery, whether internal or external*.

#### 2.2.6.1 Proposed Power Limits For Fixed User Terminals Operating Above 2 Watts EIRP

Sirius proposes that fixed user terminals operating above 2W EIRP are be subject to the same ground based limits established for WCS based stations, namely:

For the A and B blocks 100 dBμV/m (isotropic equivalent power of -44 dBm).
For the C and D blocks 90 dBμV/m (isotropic equivalent power of -55 dBm)

All measured at 2 meters above ground in a 5 MHz bandwidth.

#### 2.2.6.2 Proposed Power Limits For Fixed User Terminals Operating at 2 Watts EIRP or Below

Fixed user terminals operating at 2W EIRP or below are exempt from the ground based limits proposed here. These terminals would be subject to the Commission's equipment authorization procedures and utilize power control to adjust the output power to that sufficient to maintain the link.

### 2.2.7 Proposed Limits For Fixed User Terminal Out-Of-Band-Emissions

Sirius proposes that all fixed user terminals be subject to an OOBE limit of 75+10log(P) (-45 dBm power), measured in a 1MHz bandwidth. This requirement is 5 dB less stringent than currently in force.

## *2.3 Mobile/Portable User Terminals*

### 2.3.8 Introduction

The negative implications of the WCS Coalition's proposal to relax mobile out-of-band-emissions limits without additional constraints were discussed in Sirius and XM's previous ex parte filing.[17] The material presented here presents additional implications and describes an appropriate framework for establishing the possible performance parameters for a mobile service, given the realities of the current WCS band plan.

### 2.3.9 Proposed Power Limits for Mobile and Portable Devices

In the case of a mobile or portable user terminal as now being proposed by the WCS coalition, Sirius believes the most appropriate way to specify power and out of band limits is to directly relate them to the actual impact on the affected terminals. Sirius is proposing utilizing an interference coordination distance of 3 meters in establishing the permissible EIRP and OOBE limits for WCS mobile and portable user terminals. Sirius believes this coordination distance represents the absolute maximum interference radius around mobile WCS user terminals that the SDARS service can tolerate without significant service disruption. This distance can be contrasted with the 1 meter separation requirements advocated by the commercial mobile wireless services in various on-going FCC proceedings.[18]

In deriving the mobile EIRP limits, the measured results for Sirius reference receiver overload are used in conjunction with an estimate of path loss between the antenna connectors at a 3 meter separation to calculate the maximum EIRP that a user terminal could have without muting the reference receiver. The path loss at 3 meters is calculated by adding 3 dB to the value calculated using a free space model to account for various coupling losses.[19] The validity of this calculation has been confirmed in the experimental program conducted by Sirius (*see* Exhibit C, Section III, Figure 5). These results are calculated as a function of the serving satellite signal and the WCS signal duty cycle.

The mobile EIRP proposal is derived as follows:

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[17] Sirius and XM, *Ex Parte* Presentation, IB Docket 95-91 (filed November 30 2007).

[18] *See, e.g.*, Comments of CTIA – The Wireless Association, WT Docket No. 07-195, at 5 (filed Dec. 14, 2007)

[19] Once again, similar approaches were recommended in the AWS-3 proceeding. *See e.g.*, Comments of Verizon Wireless, WT Docket 07-195, Attachment A at 5 (filed Dec. 14, 2007).

For the “A” and “B” blocks Sirius has determined the receiver overload level from interpreting laboratory and field measurements of receiver performance.[20] In doing so Sirius has attempted to take into account the wide range of signal conditions under which interference would be experienced and to balance the needs of WCS and SDARS operators. Accordingly, a field strength of 100 dBμV/m (-44 dBm isotropically received power) has been selected as the target interference coordination level at the SDARS receiver.

At the proposed coordination distance of 3 meters, the calculated path loss is 52.2 dB using the free space + 3 dB approach.

As a result, the mobile EIRP for the A, B blocks can therefore be no more than:

$$-44 + 52.2 \text{ dBm} = \mathbf{8.2\ dBm}$$

Sirius is proposing **10 dBm (10 milliWatts)** as the mobile limit for this case.

For the “C” and “D” blocks, the receiver overload level (in isotropically received power units) has been selected in the same fashion as for the A and B blocks. A field strength of 90 dBμV/m ( -55 dBm isotropically received power) has been selected.

For a 3 meter coordination distance, the mobile EIRP can therefore be no more than:

$$-55 +52.2 \text{ dBm} = \mathbf{-2.8\ dBm}$$

Sirius is proposing **0 dBm (1 milliWatt)** as the mobile limit for this case**.**

### 2.3.10 Proposed Limits for Mobile/Portable User Terminal Out-of-Band-Emissions

Sirius is proposing a new “balanced” approach to setting out of band limits for mobile devices. In this approach the overload and out of band limits are established at the same interference distance of 3 m. The receiver impairment criteria used for the out of band limit estimation is the generally accepted 1 dB rise in satellite noise floor.[21] This level is established using the measured satellite noise floor (see Exhibit C, Appendix [1]). A bandwidth of 1 MHz is used.

The out-of-band-emissions limit is derived as follows:

First, the noise floor is estimated:

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20 *See* Exhibit C.

21 *See* “Compatibility of Services Using WiMAX Technology With Satellite Services in the 2.3 – 2.7 GHz and 3.3 – 3.8 GHz Bands,” WiMAX Forum, Section 4 (2007).

The measured noise floor in the Sirius part of the SDARS band is given in Exhibit [C], Appendix [1] as -113 dBm in a 4 MHz bandwidth.

To normalize the value to the 1 MHz bandwidth used for OOBE limit specification a correction factor of 10Log(4/1) is applied to the value.

Corrected Noise Floor = -113 dBm – 6.02 dB = ~-119 dBm in a 1 MHz bandwidth..

The interference level at the receiver that would cause a 1 dB rise in this noise floor is calculated as follows:

$IL_{WCSOOB}$ =10*log[10^( $SDARS_{NF}$ /10){10^(1/10)-1}]= -124.9 dBm in a 1MHz bandwidth.

Where

$SDARS_{NF}$ = The SDARS measured noise floor in dBm a 1 MHz bandwidth.

$IL_{WCSOOB}$= The level of emissions from the WCS mobile, in dBm, falling into the SDARS band in a 1MHz bandwidth that would cause a 1dB rise in the SDARS noise floor at the receiver.

At a coordination distance of 3 meters, the path loss is 52.2 dB using the free space + 3dB approach.

Accordingly, the out-of-band-emissions at the WCS mobile output can be no more than:

-124.9 dBm + 52.2 dB = -72.7 dBm, measured in a 1 MHz bandwidth.

This level is equivalent to a required attenuation level of 102.7 + 10 Log (P) where P is the average transmitter power in watts, measured in accordance with the requirements outlined in Section 3.

# 3 Power Measurement Issues Associated with Proposals

## *3.1 Introduction*

In order to ensure that the proposed power limits are implemented in a consistent and fair way, it is necessary to take into account significant differences in the transmitted waveforms between SDARS repeater and WCS base station and user terminals. Specifically, Wimax power measurements depend on the extensive use of frame synchronized, time gated power measurements whereas SDARS repeater measurements are based on simpler, continuous measurements.[22]

### 3.2 Proposal for Power Measurements for SDARS Repeaters

SDARS transmitter output power and out-of-band-emissions will be measured using an average power reading spectrum analyzer. The transmitter power will be measured in the Sirius channel bandwidth which is 4 MHz. The out of band power will be also be measured in a 1MHz bandwidth using an average reading spectrum analyzer,

In addition to the measurement of the average output power, the CCDF of the SDARS transmitted signal will be measured at the transmitter output.[23] The SDARS output CCDF will not exceed a peak to average ratio of 8 dB when measured at the 0.1% probability level.

### 3.3 Proposal for Power Measurements of WCS Base Stations and User Terminals

In measuring WCS base station and user terminal transmit and out of band powers, the power measurement shall include a time gating method to establish the power (peak or average) during any burst period. Sirius believes that a similar approach to defining a peak power limit as that proposed for SDARS repeaters above (i.e. peak to average ratio, based on some probability of occurrence) is needed for WCS transmissions and would welcome comments from the WCS parties as to proposed values.

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[22] *See*, *e.g.*, Power Measurement and Power Calculation of IEEE 802.16 WiMAX™ OFDMA Signals, Rohde and Schwarz, Application Note 1EF60, (http://www.rohde-schwarz.com).

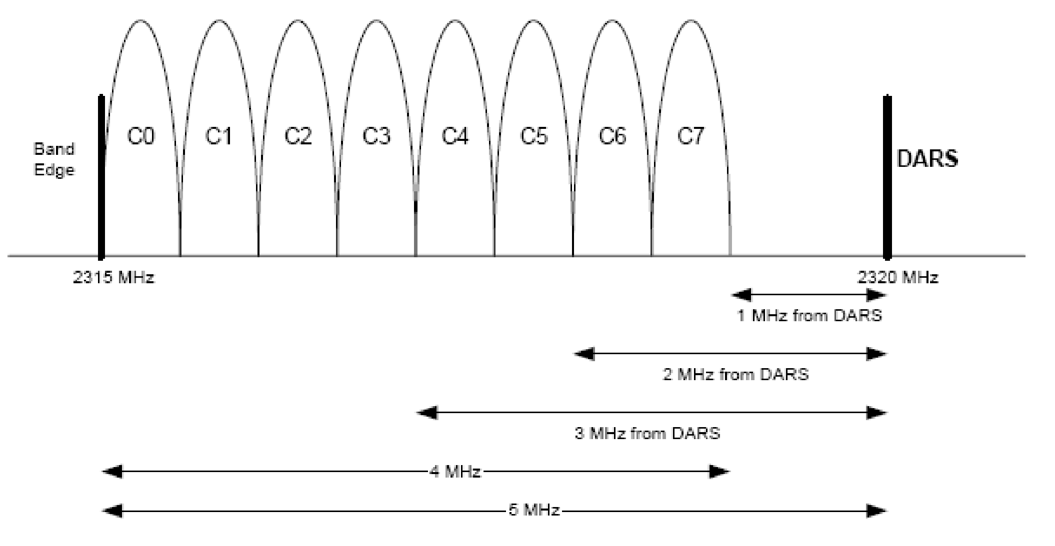
[23] *See*, *e.g.*, The Crest Factor in DVB-T (OFDM) Transmitter Systems and its Influence on the Dimensioning of Power Components, Rohde and Schwarz, Application Note 7TS02, (http://www.rohde-schwarz.com).

# Appendix 1

## Examples of Guard Band Use in WCS Fixed Wireless Equipment

### Navini Networks[1]

### Output Channels



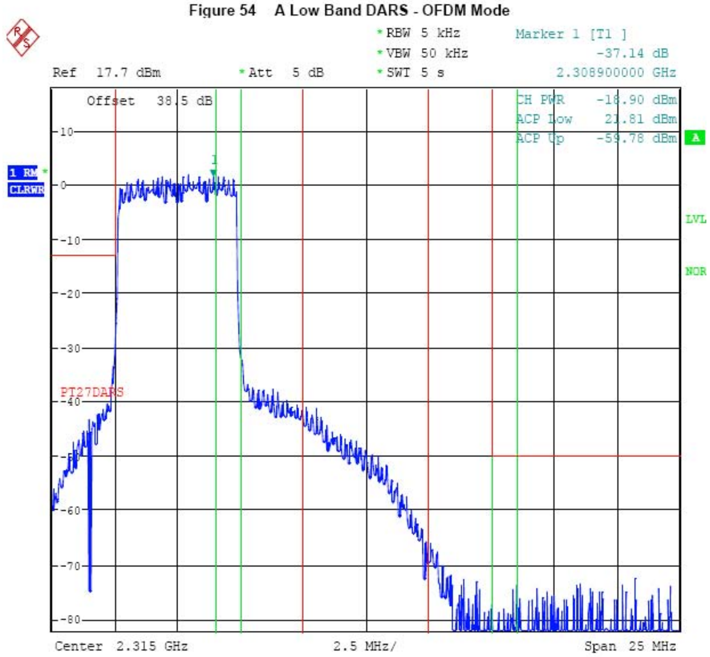

8 Carrier BTS Signal Operating in WCS C Band

1 *See* note 14, *supra.*

# Example Output Spectrum

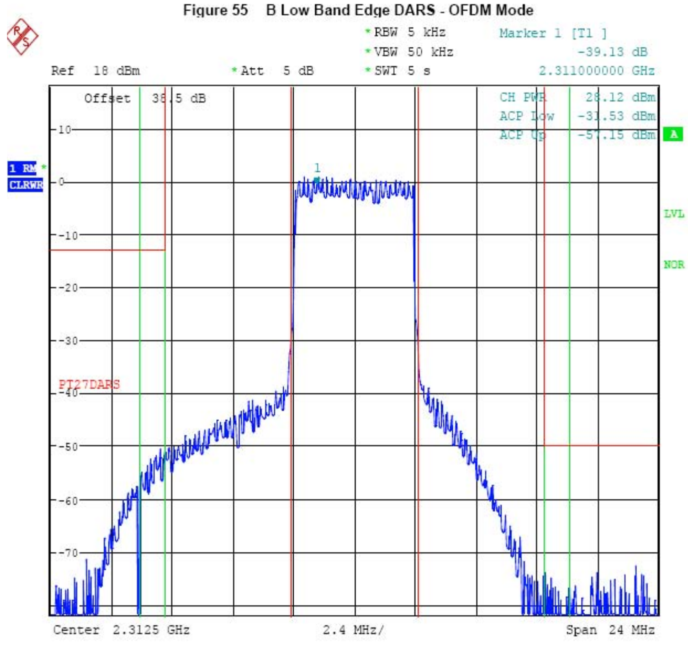
## A Block (nominal bandwidth)

Figure 54 A Low Band DARS - OFDM Mode




## B Block (nominal bandwidth)

Figure 55 B Low Band Edge DARS - OFDM Mode



## C Block (reduced bandwidth)

Figure 57 C Band DARS – OFDM 24 Subcarrier/+28 dBm Mode

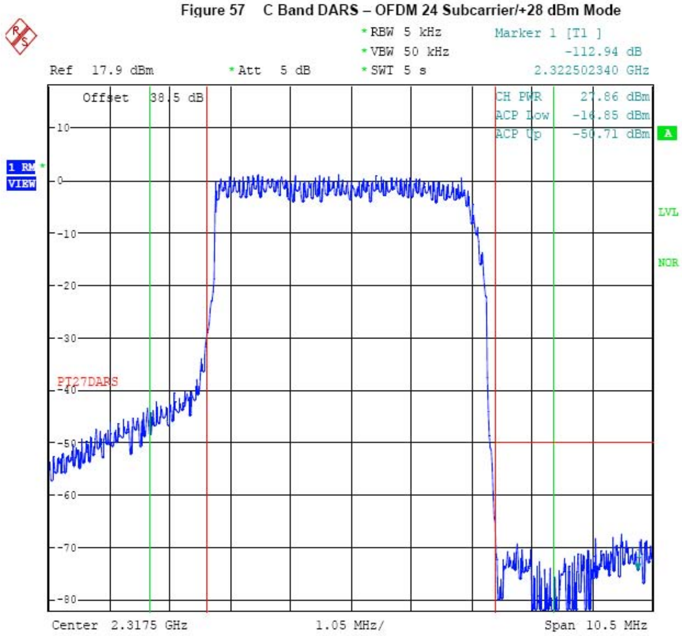
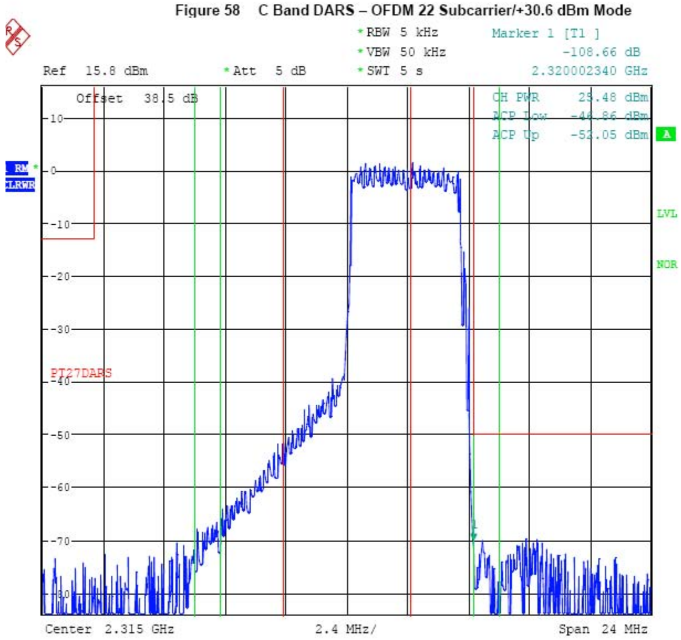



Figure 58 C Band DARS – OFDM 22 Subcarrier/+30.6 dBm Mode



# Appendix 2

## 1 Critical Factors for RF Propagation Modeling

This document briefly describes several factors that must be considered when specifying a propagation modeling method to predict ground level power flux density. A proposal or recommendation for how to specify or model each of these factors is also provided.

The following factors must be considered when selecting and using computer-based propagation models to predict received signal strength[1]:

- Propagation model and path loss calculation technique
- Frequency range of operation
- Time and location variability
- Terrain elevation modeling
- Land use modeling (clutter)
- Prediction confidence margin
- Model calibration with measured data
- Representation of physical equipment (transmitter powers, antenna patterns & gains, line losses, etc.)

### *1.1 Model Selection and path loss calculation technique:*

The purpose of the RF propagation model is to predict the excess path loss (XPL) that occurs along the propagation path in addition to free space path loss. The models listed in the table below are available and can be used for the SDARS / WCS frequency band.

| Propagation model type | Frequency Range (MHz) |
|---|---|
| Free space + RMD | 30-60,000 |
| TIREM-EDX | 30-40,000 |
| ITUR-1546 | 30-3000 |
| Longley-Rice v1.2.2 | 30 – 20,000 |
| Anderson 2D v1.00 | 30 – 60,000 |

**Proposal:** The model proposed for WCS / SDARS received power prediction is the Free space + RMD (Reflection plus Multiple Diffraction Loss) model. This model can be configured to use terrain obstacle factors, variability factors, and urban and foliage loss factors to calculate XPL. It is an appropriate model to use for microwave path design, or area-wide system studies operating at microwave frequencies (such as MDS) where the receive sites are not random or mobile locations, but engineered receive sites with

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1 The propagation modeling described here can be done using EDX Signal Pro®, however other modeling tools and software are available that provide the same functionality.

directional antennas[2]. This model would be appropriate for use in predicting ground level power flux densities.

## *1.2 Time and location variability*

Propagation modeling provides a statistical estimate of the received signal level at a location. Signal level statistical parameters for time and location can be varied to specify the margin of the calculation results. When specifying a time percentage, the calculated received power or voltage levels will be exceeded at least that percentage of time for similar propagation paths. Similarly, specifying a location percentage will produce results with received power or voltage levels exceeded at least the specified percentage of locations for similar propagation paths.

**Proposal:** The time and location percentage parameter proposed for both time and location is 50%. The statistical results for received signal strength for time and location, for all areas with similar propagation path losses, will then be unbiased about the predicted mean.

## *1.3 Terrain Elevation Modeling*

Propagation modeling tools use digitized elevation maps to place transmitters and receivers on the ground, and with specified antenna heights AGL can determine radiation center and receive antenna heights above mean sea level (AMSL). This information is then used to calculate line-of-site propagation, diffraction effects over terrain as well as terrain blockage of the propagation path between transmitter and receiver.

**Proposal:** The USGS 10/30 meter terrain databases are proposed for use in conjunction with the propagation model. These databases were developed from 1:24,000-scale 7.5-minute (or better) topographic maps by the USGS[3].

## *1.4 Land Use Modeling (Clutter)*

Propagation modeling tools use land use / land cover (LULC) data to add attenuation caused by local clutter when calculating the received signal at the receiver. Several types of clutter may contribute to the signal's attenuation, so for each clutter type a corresponding mean attenuation and height above ground level must be specified. In addition, the attenuation value for each clutter type may vary with frequency.

**Proposal:** The LULC data that is available from the USGS for the United States are proposed for use in conjunction with the propagation model. This data was derived from 1:250,000 and 1:100,000 scale maps and has been formatted into a grid spacing of approximately 200 by 200 meters[4]. The table below shows ten land use categories derived form the USGS LULC data, with values for average clutter height above ground level (ft) and losses from clutter at the receiver for the WCS and SDARS band.

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2 EDX Signal Pro® Reference Manual, Appendix A. Propagation Models, page A-2.

3 EDX Signal Pro® Reference Manual, Appendix B, page B-1.

4 EDX Signal Pro® Reference Manual, Appendix E, page E-2.

| | Land Use Category | Clutter Height (ft) | Losses from Clutter at Receiver (dB) |
|---|---|---|---|
| 1 | Open land | 0 | 8 |
| 2 | Agricultural | 0 | 20 |
| 3 | Range land | 0 | 12 |
| 4 | Water | 0 | 0 |
| 5 | Forest | 15 | 25 |
| 6 | Wetland | 0 | 5 |
| 7 | Residential | 5 | 23 |
| 8 | Mixed urban / dwellings | 15 | 23 |
| 9 | Commercial / industrial | 20 | 23 |
| 10 | Snow and ice | 0 | 0 |

### *1.5 Prediction Confidence Margin*

The prediction confidence margin is a parameter provided in some modeling tools that allows a prediction bias to be added to the calculated received signal level. This is useful, for example, to assure that the signal levels of the actual system will be at least as strong as the signal levels predicted by the model. If the confidence margin is set to 0 dB, the model will predict the expected received signal level without bias.

**Proposal:** It is proposed that the prediction confidence margin be set to 0 dB so that the prediction of received signal level is unbiased. If measured data is available that specifies the actual received signal level in the area being modeled, the prediction confidence margin can be adjusted to bring the propagation model into agreement with the actual measured data.

### *1.6 Model Calibration with Measured Data*

Propagation modeling tools can provide the means to compare the received signal levels predicted by the model with actual real-world data. Receive signal level data are collected, with location coordinates specified for each point on the map where the received signal was measured and recorded. This recorded signal level data can then be compared with the corresponding predictions of signal levels at these locations as determined by the model. A statistical comparison of these data sets can reveal if there is a bias or other variances in the modeled data, relative to the measured data.

**Proposal:** It is proposed that for each RF coverage area of interest, the propagation model first be used (with zero-bias prediction confidence margin) to predict the areas with the strongest signal on the ground. Actual received signal strength data can then be collected in these areas and statistically compared with the model's predictions. The prediction confidence margin of the model must then be adjusted to bring the expected prediction levels into agreement with the measured data.

## *1.7 Representation of Physical Equipment*

Propagation modeling tools provide the ability to input parameters specific to the particular hardware of the systems that are being modeled. In addition to antenna heights and locations, measured antenna gain patterns can be used to account for signal gains or losses that occur when the signal path passes through the antenna at various elevation and azimuth angles. Conducted transmitter power, cable losses and antenna gain patterns can then be used to determine the power radiated from the antenna at different aspect angles between the transmitter and receiver.

**Proposal:** It is proposed that the digitized antenna gain patterns, which are provided by each antenna's manufacturer, be used in the propagation modeling. This antenna gain pattern data, along with the conducted transmitter power and cable losses for each transmitter site can then be used to model the radiated power from each transmitter site.

# Appendix 3

# Ground Based Field Strength Examples

## 1 Degree Down tilt Field Strength (dBμV/m)

| | Antenna Height (m, AGL) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Downtilt 1 degree** | **5** | **15** | **30** | **50** | **70** | **90** | **110** | **140** |
| **Distance (m)** | | | | | | | | |
| **5** | 115.5 | 102.5 | 95.3 | 90.3 | 87.2 | 84.9 | 83.1 | 81.0 |
| **10** | 114.8 | 102.9 | 95.7 | 90.7 | 87.5 | 85.1 | 83.3 | 81.1 |
| **15** | 114.1 | 103.0 | 96.1 | 91.0 | 87.7 | 85.3 | 83.4 | 81.2 |
| **20** | 113.5 | 102.7 | 96.2 | 91.2 | 87.9 | 85.5 | 83.6 | 81.3 |
| **25** | 113.7 | 102.6 | 96.2 | 91.3 | 88.1 | 85.6 | 83.8 | 81.5 |
| **30** | 113.4 | 102.4 | 96.2 | 91.5 | 88.2 | 85.7 | 83.8 | 81.6 |
| **35** | 113.3 | 102.2 | 96.2 | 91.6 | 88.3 | 85.9 | 83.9 | 81.7 |
| **40** | 113.0 | 101.8 | 96.2 | 91.5 | 88.4 | 86.0 | 84.1 | 81.8 |
| **45** | 113.1 | 101.7 | 96.1 | 91.6 | 88.4 | 86.1 | 84.1 | 81.9 |
| **50** | 113.5 | 101.8 | 95.9 | 91.6 | 88.5 | 86.1 | 84.2 | 81.9 |
| **55** | 113.4 | 101.5 | 96.0 | 91.5 | 88.5 | 86.2 | 84.2 | 82.0 |
| **60** | 113.6 | 101.4 | 95.7 | 91.5 | 88.5 | 86.2 | 84.4 | 82.0 |
| **65** | 113.9 | 101.4 | 95.6 | 91.5 | 88.5 | 86.3 | 84.4 | 82.1 |
| **70** | 114.4 | 101.1 | 95.7 | 91.4 | 88.5 | 86.3 | 84.4 | 82.1 |
| **75** | 113.8 | 101.2 | 95.5 | 91.4 | 88.5 | 86.3 | 84.4 | 82.2 |
| **80** | 117.7 | 101.1 | 95.4 | 91.4 | 88.5 | 86.3 | 84.5 | 82.3 |
| **85** | 117.2 | 101.0 | 95.3 | 91.3 | 88.5 | 86.4 | 84.5 | 82.2 |
| **90** | 119.0 | 100.9 | 95.2 | 91.1 | 88.4 | 86.3 | 84.5 | 82.3 |
| **95** | 120.5 | 101.0 | 95.2 | 91.3 | 88.5 | 86.3 | 84.5 | 82.3 |
| **100** | 121.9 | 101.0 | 95.3 | 91.2 | 88.4 | 86.3 | 84.5 | 82.3 |
| **125** | 124.8 | 101.0 | 95.0 | 90.7 | 88.2 | 86.1 | 84.6 | 82.4 |
| **150** | 124.1 | 100.6 | 94.4 | 90.8 | 88.0 | 86.0 | 84.5 | 82.4 |
| **175** | 122.8 | 100.7 | 94.3 | 90.4 | 87.8 | 86.0 | 84.4 | 82.3 |
| **200** | 121.3 | 100.8 | 94.5 | 90.3 | 87.8 | 85.9 | 84.2 | 82.3 |
| **225** | 119.7 | 100.4 | 94.0 | 89.9 | 87.7 | 85.6 | 84.1 | 82.2 |
| **250** | 117.9 | 101.2 | 94.3 | 90.0 | 87.3 | 85.5 | 83.9 | 82.2 |
| **275** | 117.1 | 101.3 | 94.2 | 89.9 | 87.5 | 85.5 | 83.9 | 82.0 |
| **300** | 115.2 | 101.8 | 94.2 | 89.6 | 87.4 | 85.2 | 83.9 | 82.0 |
| **325** | 114.5 | 101.1 | 93.9 | 89.8 | 87.4 | 85.0 | 83.6 | 81.7 |
| **350** | 112.6 | 104.9 | 93.7 | 89.6 | 87.1 | 84.9 | 83.4 | 81.8 |
| **375** | 112.0 | 106.6 | 93.6 | 89.6 | 86.8 | 84.9 | 83.3 | 81.6 |
| **400** | 111.4 | 108.1 | 93.6 | 89.6 | 86.7 | 84.9 | 83.2 | 81.4 |
| **425** | 110.9 | 109.3 | 93.6 | 89.7 | 86.6 | 85.0 | 83.2 | 81.7 |
| **450** | 108.8 | 110.4 | 93.7 | 89.2 | 86.5 | 84.6 | 83.3 | 81.3 |
| **475** | 108.4 | 111.2 | 93.9 | 89.4 | 86.5 | 84.8 | 83.4 | 81.3 |
| **500** | 107.9 | 111.9 | 94.3 | 89.7 | 86.5 | 84.7 | 83.0 | 81.3 |
| **525** | 107.5 | 111.5 | 93.8 | 89.3 | 86.6 | 84.3 | 83.2 | 81.4 |
| **550** | 107.1 | 111.9 | 94.3 | 89.3 | 86.2 | 84.3 | 82.8 | 81.0 |
| **575** | 104.9 | 112.1 | 93.9 | 88.9 | 86.4 | 84.4 | 82.8 | 81.2 |
| **600** | 104.5 | 111.7 | 94.6 | 89.0 | 86.7 | 84.4 | 82.8 | 81.4 |
| **625** | 104.2 | 111.7 | 94.2 | 89.2 | 86.3 | 84.1 | 82.8 | 81.0 |
| **650** | 103.8 | 111.4 | 95.1 | 89.3 | 86.7 | 84.2 | 82.9 | 81.3 |
| **675** | 103.5 | 111.1 | 94.7 | 89.0 | 86.4 | 84.4 | 82.5 | 81.0 |
| **700** | 103.2 | 110.9 | 94.4 | 89.3 | 86.0 | 84.1 | 82.6 | 80.7 |
| **725** | 102.9 | 110.6 | 98.6 | 89.0 | 86.5 | 84.4 | 82.8 | 80.8 |
| **750** | 102.6 | 110.2 | 98.3 | 89.3 | 86.2 | 84.1 | 82.5 | 80.8 |
| **775** | 102.3 | 109.9 | 98.0 | 89.0 | 85.9 | 84.5 | 82.7 | 80.5 |
| **800** | 102.0 | 109.6 | 97.7 | 89.4 | 86.1 | 84.2 | 82.4 | 80.6 |
| **825** | 101.8 | 109.3 | 99.7 | 89.2 | 86.3 | 83.9 | 82.7 | 80.8 |
| **850** | 101.5 | 108.7 | 101.5 | 89.7 | 86.0 | 84.3 | 82.4 | 80.5 |
| **875** | 99.2 | 108.5 | 101.3 | 89.4 | 86.2 | 84.1 | 82.2 | 80.7 |
| **900** | 99.0 | 108.2 | 102.8 | 89.2 | 86.0 | 83.9 | 82.5 | 80.5 |
| **925** | 98.7 | 108.0 | 102.6 | 89.8 | 86.3 | 84.4 | 82.3 | 80.7 |
| **950** | 98.5 | 107.1 | 103.9 | 89.6 | 86.0 | 84.2 | 82.7 | 80.5 |
| **975** | 98.3 | 106.9 | 103.7 | 89.3 | 86.4 | 83.9 | 82.5 | 80.2 |
| **1000** | 98.1 | 106.7 | 103.5 | 90.1 | 86.2 | 83.7 | 82.2 | 80.5 |

## 10 degree Down tilt Field Strength (dBµV/m)

| | Antenna Height (m, AGL) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Downtilt 10 degrees** | **5** | **15** | **30** | **50** | **70** | **90** | **110** | **140** |
| **Distance (m)** | | | | | | | | |
| **5** | **117.9** | **103.5** | 96.1 | 91.1 | 88.0 | 85.7 | 83.8 | 81.7 |
| **10** | **120.2** | **104.1** | 96.6 | 91.5 | 88.3 | 85.9 | 84.0 | 81.8 |
| **15** | **127.6** | **104.7** | 97.1 | 91.9 | 88.5 | 86.1 | 84.2 | 82.0 |
| **20** | **124.0** | **104.8** | 97.4 | 92.1 | 88.8 | 86.3 | 84.4 | 82.1 |
| **25** | **117.1** | **105.3** | 97.6 | 92.4 | 89.0 | 86.5 | 84.6 | 82.3 |
| **30** | **113.4** | **105.8** | 97.7 | 92.6 | 89.1 | 86.6 | 84.7 | 82.4 |
| **35** | **110.8** | **106.3** | 98.0 | 92.8 | 89.4 | 86.8 | 84.8 | 82.5 |
| **40** | **109.0** | **106.8** | 98.3 | 92.8 | 89.5 | 87.0 | 85.0 | 82.6 |
| **45** | **107.5** | **107.7** | 98.5 | 93.1 | 89.6 | 87.1 | 85.1 | 82.8 |
| **50** | **106.1** | **108.7** | 98.4 | 93.2 | 89.8 | 87.2 | 85.2 | 82.8 |
| **55** | **105.3** | **110.1** | 98.9 | 93.1 | 89.8 | 87.4 | 85.2 | 82.9 |
| **60** | **104.1** | **112.5** | 98.7 | 93.4 | 89.9 | 87.4 | 85.5 | 83.0 |
| **65** | **103.4** | **114.9** | 99.1 | 93.4 | 90.0 | 87.5 | 85.6 | 83.1 |
| **70** | **102.3** | **127.7** | 99.6 | 93.5 | 90.0 | 87.6 | 85.5 | 83.1 |
| **75** | **101.7** | **129.7** | 99.7 | 93.7 | 90.1 | 87.7 | 85.6 | 83.2 |
| **80** | **101.2** | **121.9** | 99.9 | 93.9 | 90.2 | 87.8 | 85.7 | 83.4 |
| **85** | **100.6** | **111.4** | **100.2** | 93.8 | 90.3 | 87.9 | 85.8 | 83.4 |
| **90** | 99.7 | **109.1** | **100.6** | 93.8 | 90.3 | 87.8 | 85.8 | 83.5 |
| **95** | 99.3 | **107.9** | **101.2** | 94.2 | 90.5 | 88.0 | 85.9 | 83.5 |
| **100** | 98.8 | **106.1** | **101.3** | 94.2 | 90.4 | 87.9 | 85.9 | 83.5 |
| **125** | 96.5 | **101.0** | **104.7** | 94.6 | 90.9 | 88.1 | 86.3 | 83.9 |
| **150** | 94.9 | 98.1 | **121.1** | 95.7 | 91.3 | 88.5 | 86.5 | 84.0 |
| **175** | 93.3 | 96.2 | **110.8** | 97.1 | 91.7 | 88.9 | 86.7 | 84.1 |
| **200** | 92.1 | 94.5 | **101.4** | 98.8 | 92.3 | 89.3 | 86.8 | 84.4 |
| **225** | 91.1 | 93.0 | 98.5 | **101.0** | 93.2 | 89.5 | 87.2 | 84.5 |
| **250** | 90.2 | 91.7 | 96.2 | **112.0** | 94.0 | 90.0 | 87.4 | 84.8 |
| **275** | 89.3 | 90.9 | 94.2 | **118.7** | 95.1 | 90.4 | 87.7 | 85.0 |
| **300** | 88.6 | 89.7 | 92.7 | **106.1** | 96.4 | 91.2 | 88.0 | 85.2 |
| **325** | 87.9 | 89.0 | 91.4 | 98.8 | 98.7 | 91.8 | 88.5 | 85.1 |
| **350** | 86.9 | 88.3 | 90.8 | 96.5 | **107.0** | 92.6 | 88.8 | 85.7 |
| **375** | 86.3 | 87.4 | 89.6 | 94.6 | **115.7** | 93.9 | 89.3 | 85.7 |
| **400** | 85.7 | 86.8 | 89.0 | 93.0 | **113.7** | 95.3 | 89.9 | 85.9 |
| **425** | 85.2 | 86.3 | 88.0 | 91.5 | **103.1** | 97.4 | 90.9 | 86.7 |
| **450** | 84.7 | 85.8 | 87.5 | 90.6 | 97.0 | **102.6** | 91.8 | 86.6 |
| **475** | 84.2 | 85.3 | 86.6 | 89.4 | 94.6 | **112.2** | 92.4 | 87.2 |
| **500** | 83.8 | 84.5 | 86.1 | 88.3 | 92.8 | **113.5** | 94.1 | 88.0 |
| **525** | 83.4 | 84.1 | 85.7 | 87.9 | 91.7 | **110.3** | 95.6 | 88.3 |
| **550** | 83.0 | 83.7 | 84.8 | 86.8 | 90.8 | **100.9** | **100.8** | 88.7 |
| **575** | 82.6 | 83.3 | 84.5 | 86.5 | 89.4 | 94.8 | **108.1** | 89.7 |
| **600** | 82.2 | 82.9 | 84.1 | 86.1 | 88.6 | 93.5 | **111.6** | 90.4 |
| **625** | 81.9 | 82.5 | 83.7 | 85.2 | 87.8 | 92.3 | **111.3** | 91.4 |
| **650** | 81.5 | 82.2 | 83.0 | 84.8 | 86.7 | 90.5 | **107.1** | 92.7 |
| **675** | 81.2 | 81.9 | 82.6 | 84.5 | 86.4 | 89.5 | 99.1 | 93.4 |
| **700** | 80.9 | 81.6 | 82.3 | 83.7 | 86.0 | 88.7 | 94.3 | 98.7 |
| **725** | 80.6 | 81.3 | 82.0 | 83.4 | 85.1 | 87.8 | 91.8 | **104.5** |
| **750** | 80.3 | 80.6 | 81.7 | 83.1 | 84.8 | 87.1 | 90.7 | **108.2** |
| **775** | 80.0 | 80.3 | 81.4 | 82.8 | 84.5 | 86.3 | 89.6 | **109.9** |
| **800** | 79.7 | 80.1 | 81.2 | 82.0 | 83.6 | 86.1 | 88.7 | **108.5** |
| **825** | 79.5 | 79.8 | 80.5 | 81.8 | 83.3 | 85.4 | 87.8 | **105.0** |
| **850** | 79.2 | 79.5 | 80.2 | 81.5 | 83.1 | 84.3 | 87.0 | **101.4** |
| **875** | 78.9 | 79.3 | 80.0 | 81.3 | 82.2 | 84.1 | 86.7 | 92.4 |
| **900** | 78.7 | 79.0 | 79.7 | 81.0 | 82.0 | 83.9 | 86.0 | 91.0 |
| **925** | 78.5 | 78.8 | 79.5 | 80.3 | 81.8 | 82.9 | 85.2 | 89.7 |
| **950** | 78.2 | 78.6 | 79.3 | 80.1 | 81.5 | 82.7 | 84.6 | 89.5 |
| **975** | 78.0 | 78.3 | 79.1 | 79.9 | 80.8 | 82.5 | 84.3 | 88.4 |
| **1000** | 77.8 | 78.1 | 78.8 | 79.6 | 80.6 | 82.3 | 83.7 | 87.4 |

# Exhibit B

# Grandfathering

# 1 Introduction

Grandfathering is not a real issue for WCS. With the deployment of reasonable SDARS filters on WCS base stations, and the deployment of AGC circuitry in the WCS CPE (Customer Premise Equipment) receivers, the task of providing quality service in the vicinity of SDARS high power repeaters is straightforward.[1] By taking into account the existing DARS repeaters the WCS operators can deploy base stations in the area near a potentially problematic repeater to insure that adequate signal power is available to the CPE receiver in regions were the AGC threshold is exceeded by the SDARS transmitter. Sirius and XM Radio have demonstrated the successful coordination of their repeater networks using this system design technique and there is no reason why that success cannot be duplicated by WCS system operators. In addition, field tests have confirmed the lack of impact on fixed WCS terminals from nearby SDARS transmitters[2].

It has also been demonstrated that converting a single high power site into multiple lower power sites will actually generate more, not less potential for interference[3]

In this Exhibit we show the actual operating distribution of transmitter powers which illustrates that the repeater operations being considered for grandfathering currently operate at relatively low powers. Over 39% of the sites are at 2 kW or less and over 69% of the sites are at 4 kW or less.

Additionally, Sirius summarizes the potential impact should it be required to change out all of its repeater sites above 2 kW.

---

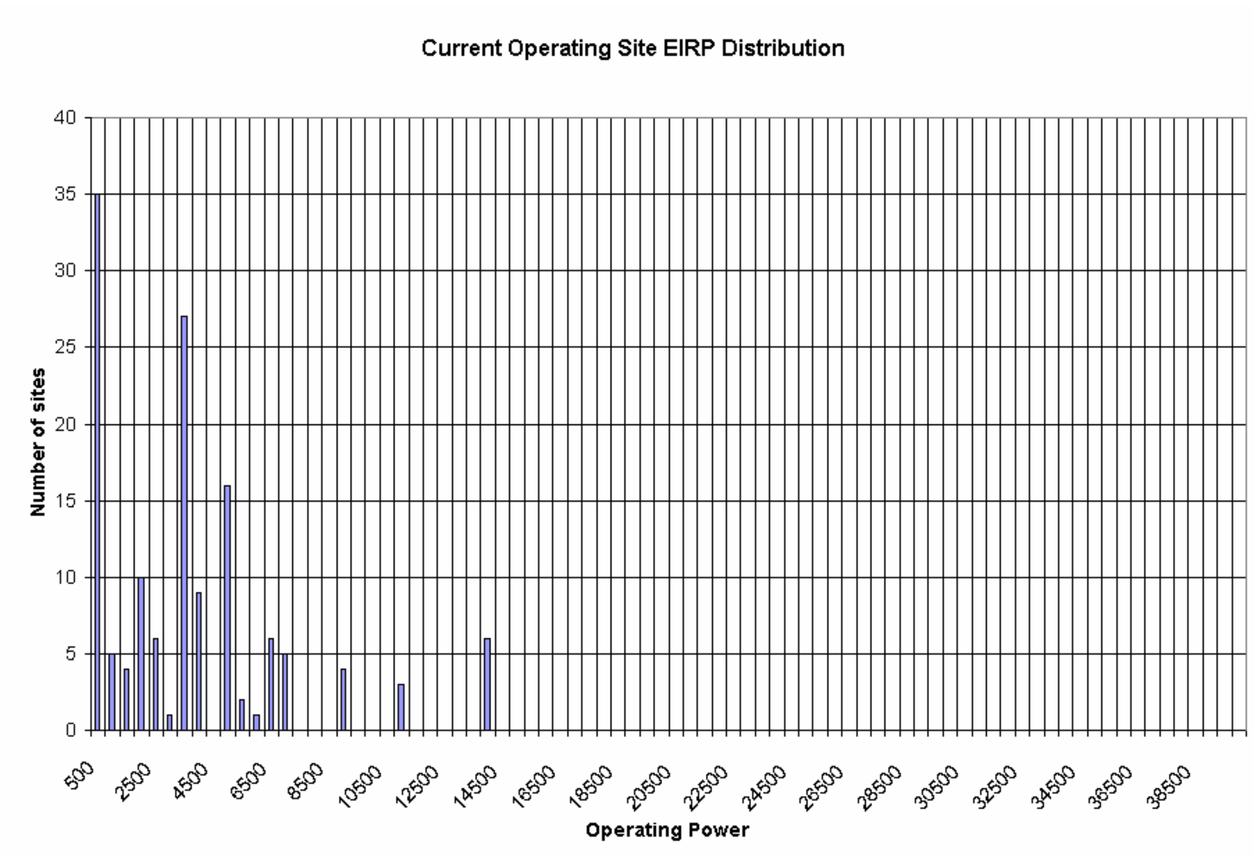
1 *See* Letter from Bruce D. Jacobs, Counsel for XM Radio Inc., to Ms. Magalie Roman Salas, FCC, IB Docket No. 95-91 (August 29, 2001) ("XM White Paper"), at 3-10.

2 *See* Comments of XM Radio Inc., Exhibit A, IB Docket No. 95-91 (filed December 14, 2001).

3 *XM White Paper* at 15-20.

# 2 Current Network Operating Levels

The following chart is a histogram showing the distribution of the current Sirius terrestrial network Sites.



# 3 Economic and Schedule Impact

The following is a summary of some of the significant issues that arise as a result of redesigning the existing Sirius repeater network to a 2000 watt average power limit.

- Several hundred additional sites would be required to recover the loss in coverage due to changing out higher power sites for those at 2 kW.

- The estimated deployment timeframe for the nationwide deployment would be at least 24 months, subject to further delays in difficult to zone markets.

- The required effort to optimize the new network would cause severe disruption to the service in the markets were new repeaters were introduced.

- The existing and new networks would have to exist simultaneously so that in the off peak hours (1-4AM) the network could be reconfigured to conduct drive tests and verify performance. This would mitigate some of the disruption to the current users but lengthen the over all time to finalize the new network for commercial service.

- The non-recurring costs for the site acquisition, construction and commissioning activities would be in the tens of millions of dollars range.

- Significant additional recurring costs would also be incurred in the form of additional leases, utility, and operation and maintenance costs to operate the new repeaters.

# Exhibit C

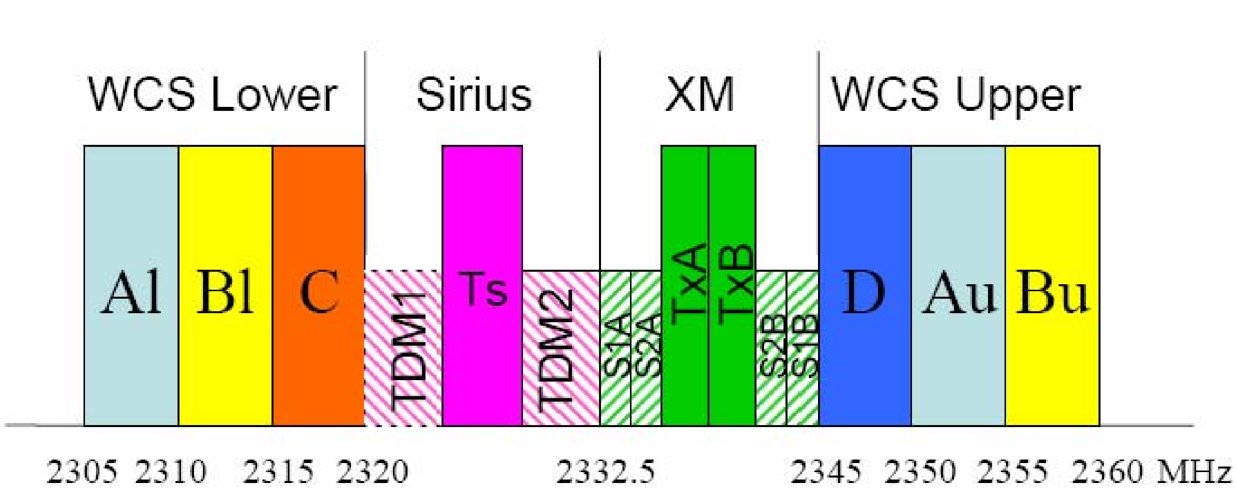
# Experimental Measurements of Overload Interference from WCS Transmitters to SDARS Receivers and the SDARS Noise Floor

# 1. Introduction

Sirius has conducted a series of laboratory and field tests to establish the signal levels that would block the reception of the SDARS service satellite signals due to overload interference from devices deployed in various WCS blocks. These tests were observed and approved for accuracy by the Cavell, Mertz & Associates, Inc., an independent wireless engineering firm.

Also attached to this section are tests that were conducted by independent engineering authorities at the EMI Research and Development Laboratory of the Florida Atlantic University to confirm the value of the received noise floor in the presence of no interference, appropriate for out of band emissions calculations in the SDARS service bands, as well as to measure the overall path loss between the WCS transmitter and the Sirius receiver at three meter interference coordination distance.

The following chart illustrates the SDARS WCS spectrum plan for reference in the following discussion.




TDM1 = Lower band Sirius satellite channel
TDM2 = Upper band Sirius satellite channel
Ts = Sirius COFDM terrestrial transmission channel
TxA and TxB= Two sub-bands (ensembles) of XM terrestrial transmission channels
S1A and S1B= Two ensembles of XM's first satellite
S2A and S2B= Two ensembles of XM's second satellite

**Figure 1: WCS/SDARS Band Plan**

The following assumptions were used during these tests:

- The WCS operators' deployment will be based on the 802.16e WiMAX standard.
- The services provided by the WiMAX providers will include a range of defined WiMAX profiles.
- The tests used standard off-the-shelf test equipment along with reference IEEE 802.16e WiMAX signals supplied by the test equipment vendor.
- A Sirius reference receiver was used for the tests. This represents the majority of the Sirius receiver platforms deployed in the market including the automotive OEM market where typical product lifecycles are 10 years.
- Interference conditions to the lower Sirius satellite signal (TDM1) was tested using the lower WCS frequency blocks (A-lower, B-lower, C) as the interfering sources.
- The tests were conducted with representative WCS WiMax signal transmit profiles with different WiMAX Transmit duty cycles. Field test results reflect only a 6% transmit burst profile. Sirius believes this burst profile is representative of a Voice over IP (VoIP) call.
- During the laboratory tests, the desired SDARS signal was set to a reasonable satellite signal level on the ground for the testing at -100dBm while testing the interference conditions with variable WCS interference signal levels.
- During the field tests, the interference impact on individual SDARS satellite links was observed.

## 2. Test Set Up and Description

The test effort includes a laboratory component and a field component. The laboratory tests were designed to determine the overload levels (in dBm) for Sirius' satellite receivers in response to terrestrial WCS interference signals. An extended discussion of the causes of WCS overload interference can be found in a previously published Sirius document.[1] Sirius defines the overload point to be the received WCS interference power at which the audio stream experiences unrecoverable errors, *i.e*. creation of audio muting to cause service interruptions and customer dissatisfaction.

The laboratory tests were executed in a conducted environment, with the instrumentation and relevant equipment connected by cable to measure the levels of WCS interference causing audio muting.

The field tests were designed to determine the distances that a WCS emitter causes overload interference to a Sirius receiver, as well as the maximum WCS transmit power to interfere with a Sirius receiver at a three meter distance.

[1] *See* White Paper: Interference to the SDARS Service from WCS Transmitters, attached to Letter from Carl R. Frank, Counsel to Sirius Satellite Radio Inc., to Marlene H. Dortch, Secretary, FCC, WT Docket No. 05-256 and IB Docket No. 95-91 (filed Mar. 29, 2006) ("2006 Sirius White Paper").

An independent third party report presenting the Sirius satellite receiver's interference-free noise floor level is presented.

## 2.1. Laboratory Tests

### 2.1.1. Test Setup:

Sirius SDARS satellite and terrestrial signals (TDM1, TDM2 and COFDM) were generated in the laboratory using SDARS signal generators, while the field tests used the live, over-the-air Sirius broadcast signals.

Overload tests were done with a single serving signal active, e.g. TDM1, TDM2 or COFDM. The serving signals for TDM1 and TDM2 were -100 dBm, with COFDM set to -95 dBm.

Sirius created the WCS interference signals using an Agilent E4438C generator equipped with the capability to create and run 802.16e mobile WiMAX waveforms. The waveforms are based on a 5 MHz TDD profile at various duty cycles to emulate downlink or uplink traffic. The interference signals operated in the lower A and B blocks or C block, depending on the test performed..

The test setup is shown below in Figure 2. The output of the WiMAX signal generator, centered at the tested WCS channel center frequency, passed through a band pass filter appropriate for the respective WCS block. After passing through an isolator and variable attenuator, the WCS signal was combined with the desired Sirius signal through a directional coupler. The composite signal was then split, with one path routed to a spectrum analyzer/power meter (Rohde and Schwarz FSQ-26) for monitoring the signal levels and the other to the input of the Sirius satellite radio receiver's RF front-end Low Noise Amplifier (LNA). The LNA was originally embedded in an actual production Sirius antenna module, and removed and repackaged in a suitable enclosure for use in laboratory testing. The output of the LNA was applied to the victim satellite radio receiver input, and the receiver's audio output connected to a speaker to monitor and detect audio interruptions.

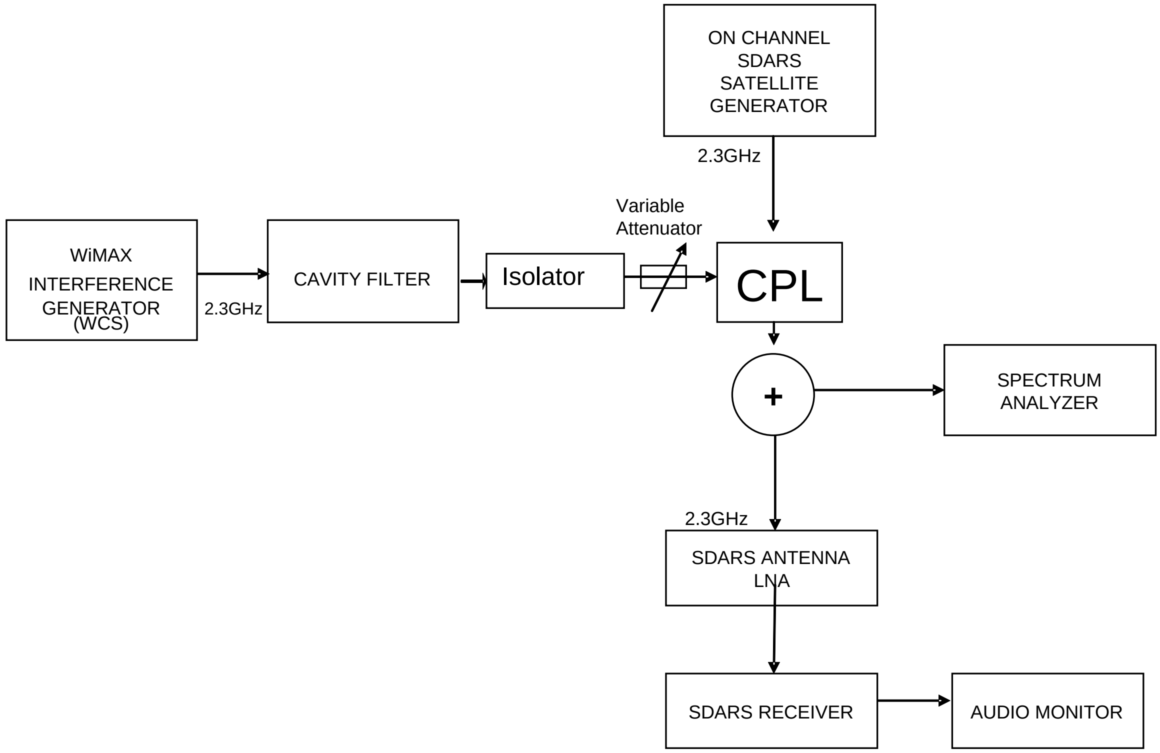



**Figure 2: Laboratory Test Block Diagram**

### 2.1.2. Laboratory Test Procedure

For each test case, the following procedure was used to conduct the tests. The steps below are simplified and occur after the system has been configured and calibrated.

- Set the satellite radio TDM1/TDM2 serving signal to a level of -100 dBm at the LNA input. For COFDM signals, the level is -95 dBm.
- For each serving signal, increase the WCS signal from a low level until audio muting occurs in the SDARS receiver.
- Reduce the WCS signal in 1 dB steps until audio is restored.
- Fine tune the WCS signal level to the highest setting where the satellite receiver will play unimpaired audio for one minute. This setting is then recorded as the maximum tolerable WCS interference level before the onset of audio muting.

The preceding steps are repeated for different permutations of WCS frequency block and WiMax profiles and duty cycles.

## 2.2. Field Tests

Field tests demonstrated the distances at which interference from an emulated WCS mobile device cause muting in the Sirius receiver. In contrast to the laboratory tests, these tests were conducted under the best case conditions: in an open environment, with full satellite link margin. In addition, the test team executed a test to determine the net path loss between the WCS transmitter and SDARS receiver at three meter separation distance.

### 2.2.1. Field Test Setup:

Figure 3 shows the block diagram of the field test scenario. The tested WCS transmitter setup consists of a WiMAX signal generator (Agilent E4438C), amplifier (Stealth Microwave SM2025-44L), filter, WCS transmitter antenna and required cabling. The signal generator output fed a power amplifier, and the radiated interference signal levels adjusted to achieve the tested WCS interferer transmit power level (i.e. 250 mW for interference distance tests). The amplifier output is then fed into a band pass filter (selected by WCS Block) which is in turn connected to the antenna. The antenna is a vertically polarized dipole with an overall antenna gain of 0 dBi toward the horizon. The WCS transmitter equipment suite was mounted on a cart, with the antenna elevated approximately six feet above ground.

On the victim side, the Sirius receivers were installed in the typical vehicle Original Equipment Manufacturer (OEM) factory installation fashion: antenna mounted on the rear portion of a sedan roof, with the receiver inside the vehicle. A directional coupler was inserted in-line with the SDARS antenna output to measure the received desired and undesired WCS interference signals on a spectrum analyzer. Figure 4 shows a photograph of the test setup with the mobile WCS transmitter approximately 130 feet (40 meters) from the victim SDARS receiver in the vehicle .

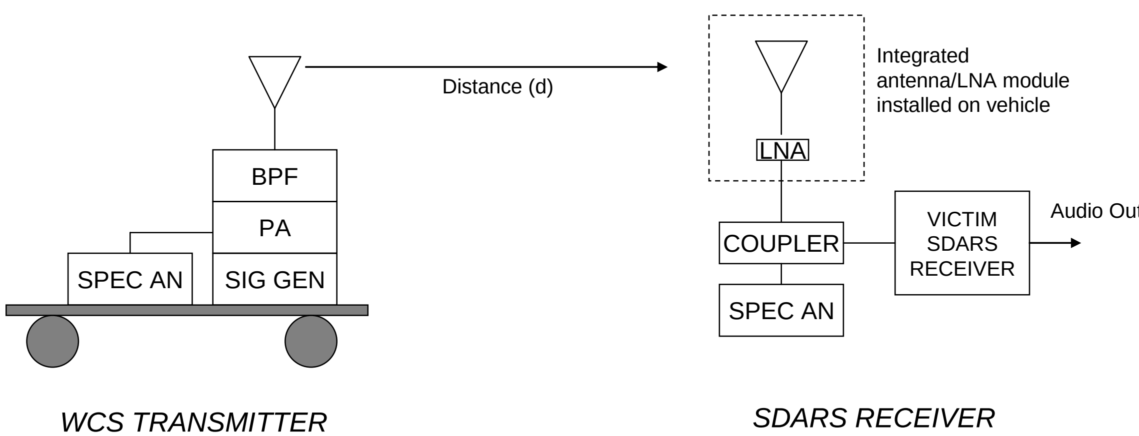



**Figure 3: Field Test Block Diagram**

**Figure 4: WCS Transmitter Interference Distance Measurement Test where the WCS transmitter power was fixed at 250 mW and the interference distance between the WCS transmitter and the Sirius OEM vehicle installed receiver was measured. The radio was muting at this point.**

#### 2.2.2. Field Test Procedure:

The test team first set the WCS transmitter to an EIRP of 250 mW (24 dBm). Starting from a distance close enough to cause the victim satellite radio receiver to lose signal lock, the transmitter cart was moved away from the OEM vehicle with installed satellite radio receiver in 1 meter increments until reception was restored. The test team then varied the position of the cart along the radial until at least 60 seconds of error free satellite radio reception was observed. This process was repeated to confirm the measurement results. The test team then logged the received power versus. distance from the vehicle.

A second test determined the maximum WCS transmitter power that allows error free satellite radio service reception at a three meter distance. For this test, the cart was fixed at a point three meters from the satellite radio receiver antenna location on the OEM vehicle. The test team increased the transmit power until the receiver lost signal lock, and then reduced the power in 1 dB increments until error free audio was observed for 60 seconds. The corresponding transmit and received powers were then logged.

The preceding tests were repeated for different permutations of interfering WCS Block and WiMax profiles.

## 3. Test Results

### 3.1. Laboratory Test Results:

Table 1 below shows the maximum WCS interference levels, in dBμV/m, where interference was logged. Increasing the WCS interferer beyond these levels caused the onset of muting in the audio stream. Note in Table 1 that the logged interference power levels are reported as burst power levels in dBμV/m.

| OVERLOAD INTERFERENCE - BURST POWER (dBμV/m) | | | | |
|---|---|---|---|---|
| **Burst Rate** | **Signal Received** | **A-I** | **B-I** | **C** |
| 50% | TDM1 | 103.8 | 99.8 | 69.7 |
| | TDM2 | 105.8 | 104.8 | 75.6 |
| 7% | TDM1 | 97.7 | 92.9 | 74.3 |
| | TDM2 | 100.6 | 96.7 | 79.4 |

| OVERLOAD INTERFERENCE - BURST POWER (dBuV/m) | | | | |
|---|---|---|---|---|
| Burst Rate | Signal Received | A-I | B-I | C |
| 50% | TDM1 | 103.8 | 99.8 | 69.7 |
| | TDM2 | 105.8 | 104.8 | 75.6 |
| 7.00% | TDM1 | 97.7 | 92.9 | 74.3 |
| | TDM2 | 100.6 | 96.7 | 79.4 |

**Table 1: Laboratory Test Results**

### 3.2. Field Test Results:

Table 2 below shows the minimum distance at which the interference conditions were not observed in the presence of a 250 mW WCS transmitter. This test was executed under the best case satellite radio signal reception conditions; in the clear line of site with full desired serving signal link margin. Moving the WCS transmitter closer to the victim receiver caused a loss of satellite audio service.

| Band-Duty Cycle | A-6% | B-6% | C-6% |
|---|---|---|---|
| **TDM1** | 19.2 m | 18.3 m | 39.0 m |
| **TDM2** | 19.2 m | 17.7 m | 34.4 m |

**Table 2: Stationary Field Tests,-Distance to Mute With a 250 mW WCS Transmitter**

For the results in Table 3, the distance between the WCS transmitter and the OEM satellite radio victim receiver was fixed at three meters, and the WCS interferer transmit power was varied. The results shown below indicate the maximum WCS transmit power before the loss of satellite audio service.

| Band-Duty Cycle | A-6% | B-6% | C-6% |
|---|---|---|---|
| **TDM1** | 0 dBm | 1 dBm | -9 dBm |
| **TDM2** | 5 dBm | 7 dBm | -10 dBm |

**Table 3 Field Tests -Measured WCS Transmitter Power at Onset of Muting at a 3 meter OEM satellite radio receiver separation**

In addition to the tests discussed above, the team also measured the received power level at the receiver as the transmitter was moved away in 1 meter increments in order to determine the path loss. Using the known transmitted and received powers, the overall path loss between the WCS transmitter output and the Sirius LNA input was measured with results shown in Figure 5 below. The results shown in Figure 5 are in agreement with the overall interference power loss assumption of Free Space Path Loss plus 3 dB which is applied in the analysis throughout this document.

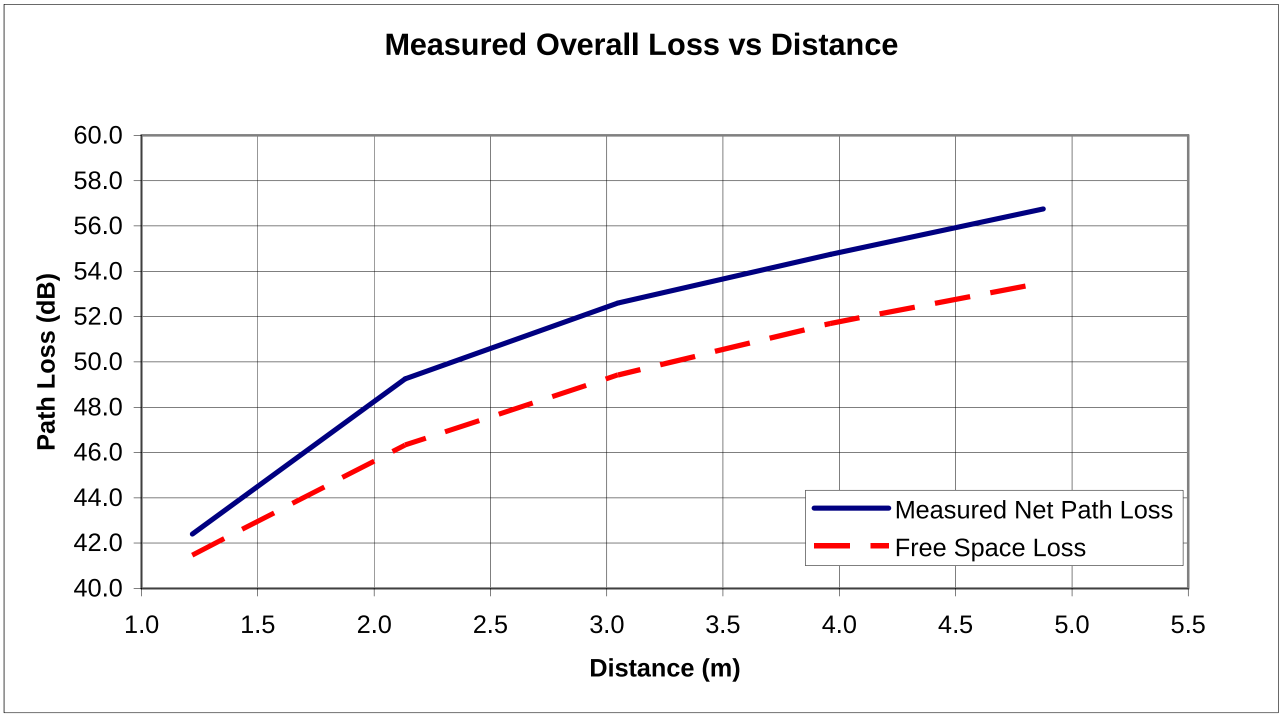



**Figure 5: Measured Loss Between WCS Transmitter and Sirius LNA vs, Free Space Path Loss**

### 3.3. Noise Floor Test Results

The results of the noise floor tests are shown in Appendix [1]. This data confirms that the operating noise floor for the Sirius satellite service is -113 dBm in the 4 MHz satellite radio channel.

## 4. Discussion Of Results

These test results demonstrate the following:

- The level that SDARS receivers experience blanketing interference can be broken down into two major categories for a 250 mW WCS transmitter.
  - WCS C block (Muting at larger than 100 feet (30.5m) separation)
  - WCS Lower A&B block (Muting at larger than 50 feet (15 m) separation)
- Previous SDARS proposals for WCS interference coordination have assumed a guard band that would be required for WCS C block devices to meet the WCS out of band emission limits. The tests demonstrated that if no guard band was in place, a level of 90 dBμV/m (-55 dBm) or lower WCS field strength limit at the satellite radio receiver would be required to protect the SDARS receiver for the WCS C block emissions.
- The results of the 3 meter distance test indicate that in the A-lower and B-lower blocks, a WCS transmit power of 7 dBm (5 mW) or less is required for uninterrupted SDARS service delivery. In the C-block, the results suggest a WCS transmit power limit of -10 dBm (0.1 mW) under the same distance conditions.
- The noise floor level appropriate for out of band emissions calculations is -113 dBm in the 4 MHz Sirius satellite radio channel.

# Appendix

FAU FLORIDA ATLANTIC UNIVERSITY

FAU EMI R&D LAB

EMI Research and Development Laboratory
Department of Electrical Engineering
Florida Atlantic University
3998 FAU Blvd, Suite 310
Boca Raton, Florida 33431
(561) 361-4390

Technical Report No. 07-119b

# Noise Floor Measurement in the Satellite Radio Band for Sirius Satellite Radio Systems

| | |
|---|---|
| Performed: | 26 November 2007 |
| Customer: | Think Wireless, Inc.<br>5497 Wiles Road, Suite 205<br>Coconut Creek, FL 33073 |
| Company Official Responsible for Product(s) Tested: | Argy Petros, Ph.D., President<br>(954) 977-4470 |
| Test Performed and Reported by: | Jean-Charles Yves-Thierry<br>Thierry Jean-Charles, BSEE<br>FAU EMI R&D Laboratory |
| Approved by: | Vichate Ungvichian, Ph.D., P.E.<br>Director, FAU EMI R&D Laboratory |

# 1. INTRODUCTION

This document presents the results for the noise floor measurements for Sirius Satellite Radio Systems. The results apply only to the specific items of equipment, configurations and procedures supplied to the Florida Atlantic University EMI R&D Laboratory as reported in this document.

# 2. OBJECTIVE

This evaluation was performed to determine the sensitivity of Sirius Satellite Radio Systems in their Digital-Audio-Radio-Services (DARS) receive frequency allocation through noise floor measurements.

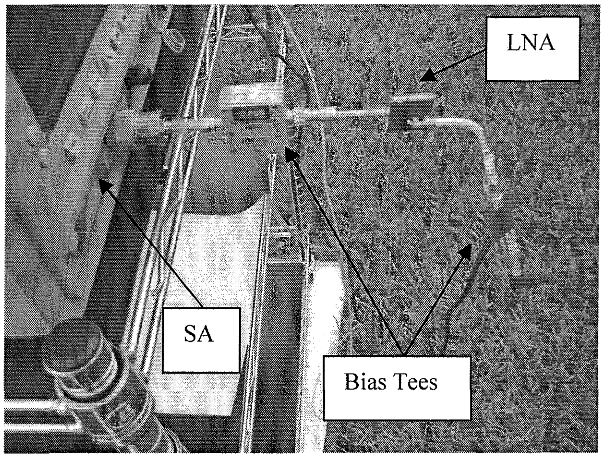
# 3. CONCLUSION

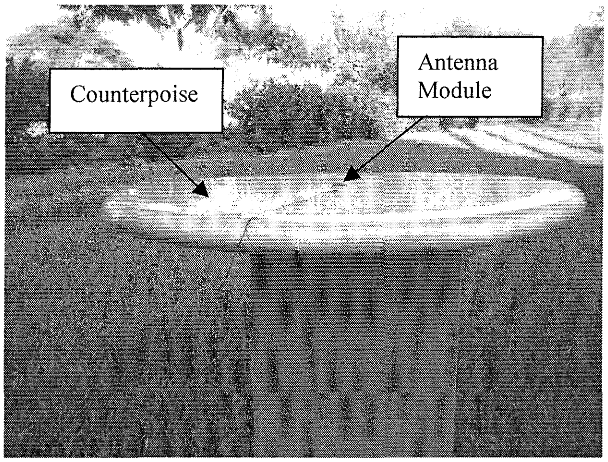
The noise floor level for Sirius Satellite Radio Systems, in their DARS receive frequency allocation, was determined to be -113 dBm (lower-edge of Sirius DARS band), as described in the following pages.

# 4. TEST PROCEDURES AND RESULTS

## 4.1 TEST PROCEDURES

The Sirius Satellite Radio receiver noise floor measurements were executed outdoor. The Satellite Digital-Audio-Radio Service (DARS) antenna module for the Sirius Satellite receivers, which consists of an antenna, a low-noise amplifier (LNA) and a 21-foot cable, was placed on a 3-foot diameter aluminum counterpoise. The antenna module was connected in series with a low-noise amplifier of 16-dB gain to the input of an Agilent E4404B spectrum analyzer (SA). Bias tees were used to activate the LNAs. Photographs 1 and 2 and Diagram 1 depict the measurement setup.




**Photographs 1 & 2: Measurement Setup**

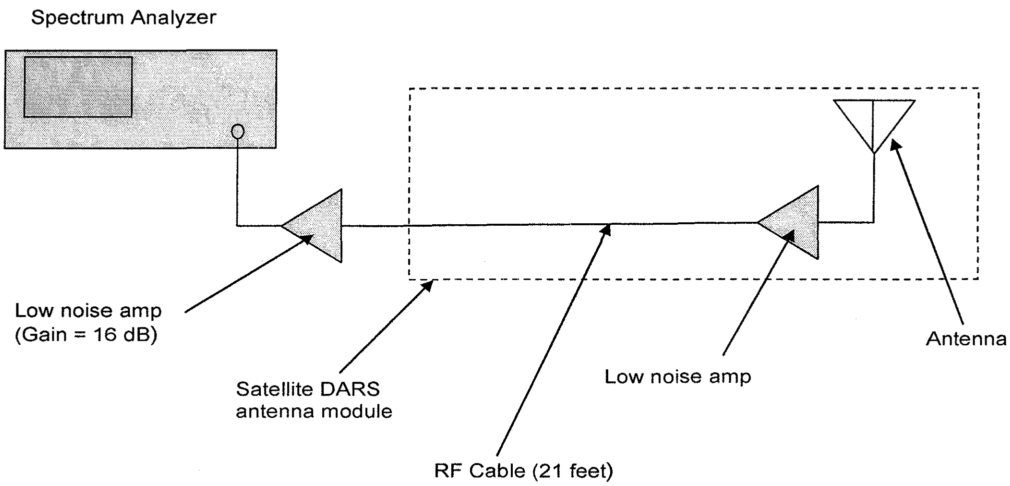



**Diagram 1: Measurement Setup**

## 4.1.1 SIRIUS NOISE FLOOR MEASUREMENTS

The DARS band corresponding to the Sirius Satellite Radio system was identified on SA (Diagram 2). The frequency span was then reduced to encompass only the DARS band covered by the Sirius TDM 1 Satellite, which ranges from 2320 MHz to 2324 MHz. Afterward, the location of the antenna module with counterpoise was changed so that the incident Sirius satellite signal is blocked by the test building. The noise floor of the system was measured using a resolution bandwidth and a video bandwidth of 3 kHz over the 4 MHz span. The data was recorded with SA on "max hold" and was averaged using a sweep count of 25. Figure 1 shows the result for the noise floor measurements for the Sirius Satellite receiver.

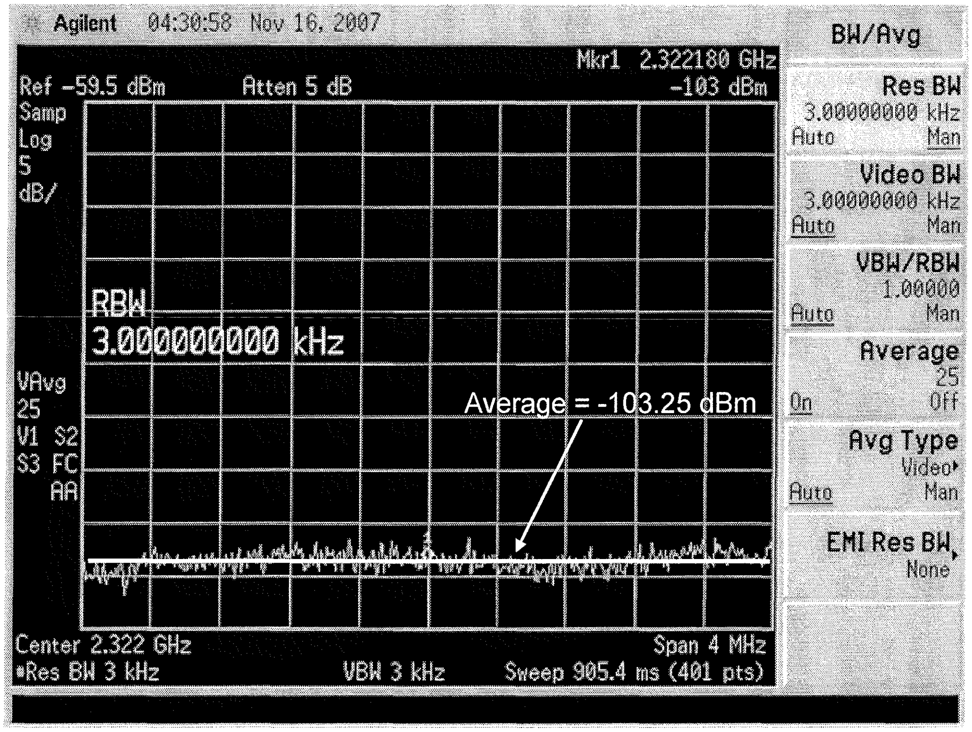



**Figure 1: Sirius TDM 1 Satellite Noise Floor Measurements**

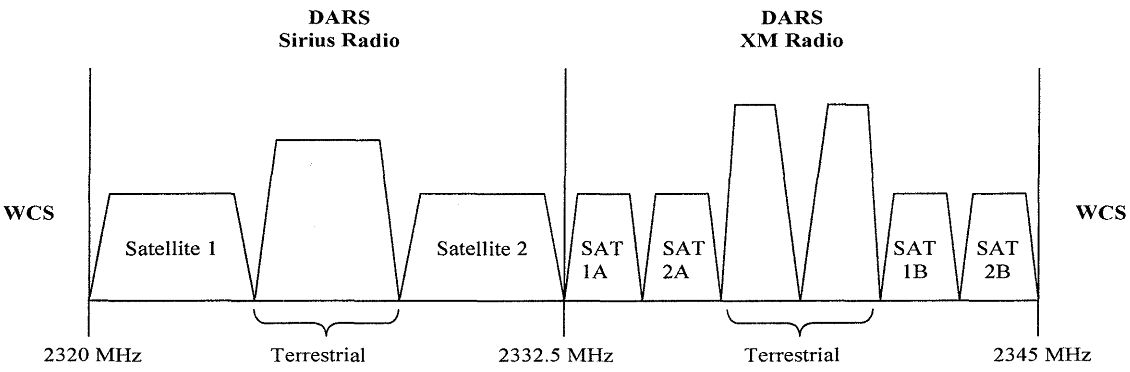



**Diagram 2: DARS Receive Frequency Allocation**

## 4.2 TEST RESULTS

Based on Figure 1 and the following parameters:

- Spectrum analyzer reading SA_NF (dBm)
- LNA in front of the Spectrum Analyzer, SA_LNA = 16 dB gain
- Spectrum Analyzer Resolution Bandwidth, RBW = 3 kHz
- Bandwidth of satellite signal, BW = 4 MHz
- Antenna module LNA gain (including the 21-foot cable loss), ALNA = 25 dB,

the calculated noise floor for the Sirius Satellite Radio receivers is recorded in Table 1.

| Satellite Receiver | Figure No. | SA_NF (dBm) | SA_LNA (dB) | ALNA (dB) | BW (MHz) | RBW (kHz) | Calculated Noise Floor (dBm)* |
|---|---|---|---|---|---|---|---|
| Sirius | 1 | -103.25 | 16 | 25 | 4 | 3 | -113.00 |

**Table 1: Calculated Noise Floor at the Front-End of the Satellite Receiver**

*Calculated Noise Floor (dBm) = SA_NF (dBm) – SA_LNA (dB) – ALNA (dB) + 10*LOG(BW/RBW)

Hence the calculated noise floor at the front-end of the satellite receiver is

- Sirius TDM1
  - SA_NF = -103.25 dBm
  - Calculated Noise floor = -113.00 dBm

## MAJOR TEST EQUIPMENT

| Equipment Type | Manufacturer | Description | Model | Serial No. |
|---|---|---|---|---|
| Spectrum Analyzer | Agilent | 9 kHz - 6.7 GHz | E4404B | MY41440110 |

# End of Report

**CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION**

I, Terrence R. Smith, am the Senior Vice President, Technology at Sirius Satellite Radio Inc. I joined Sirius in 2002 and have been involved in digital technology for approximately 28 years. Prior to joining Sirius, I was employed at RCA Labs and Sarnoff Corporation. I hold a Bachelor of Science in Electrical Engineering from the University of Notre Dame and a Master of Science in Electrical Engineering from Drexel University.

I hereby declare under penalty of perjury that I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing Comments of Sirius Satellite Radio Inc. and any attachments, that I am familiar with Part 25 and Part 27 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in the Comments of Sirius Satellite Radio Inc. and any attachments, and that it is complete and accurate to the best of my knowledge and belief.

Terrence R. Smith

Terrence R. Smith
Senior Vice President, Technology
Sirius Satellite Radio Inc.

Dated: FEBRUARY 14, 2008

**THIRD PARTY TECHNICAL CERTIFICATION**

I, Michael D. Rhodes, am a Senior Engineer with the firm of Cavell, Mertz & Associates, Inc. in Manassas, Virginia, a position I have held for approximately 10 years. I am a registered Professional Engineer in the Commonwealth of Virginia and I hold a Bachelor of Science degree in Electrical Engineering from Virginia Polytechnic Institute and State University. I have submitted numerous engineering exhibits to the Federal Communications Commission and my qualifications are a matter of record with that agency.

I hereby declare under penalty of perjury that I participated in laboratory and field testing with Sirius Satellite Radio Inc. in connection with the technical information submitted in the foregoing Comments of Sirius Satellite Radio Inc. and associated attachments. I have reviewed those test results and the engineering information submitted in the Comments of Sirius Satellite Radio Inc. and associated attachments, and that it is complete and accurate to the best of my knowledge and belief.

Michael D. Rhodes, P.E.
Cavell, Mertz & Associates, Inc.
7839 Ashton Avenue
Manassas, Virginia 20109-2883

February 14, 2008